OPERATING AND SERVICE MANUAL

(hp PART NO. 410C-903)

MODEL 410C

ELECTRONIC VOLTMETER

SERIALS PREFIXED: 433

Appendix C, Manual Backdating
Changes adapts this manual to
Serials Prefixed:
311, 328, 339 and 344

01556-3

Printed: FEB. 1965

CAUTION

ONE SIDE OF ALMOST ALL POWER DISTRIBUTION SYSTEMS IS GROUNDED. EXTREME CAUTION MUST BE USED IF DIRECT MEASUREMENT OF POWER LINE VOLTAGES IS ATTEMPTED. IF THE GROUND CLIP LEAD IS ACCIDENTALLY CONNECTED TO THE UNGROUNDED SIDE OF THE LINE, SEVERE DAMAGE TO THE 410C IS POSSIBLE BECAUSE OF THE SHORT CIRCUIT CREATED. POWER LINE VOLTAGES CAN BE SAFELY MEASURED BY USING THE PROBE TIP ONLY. CONTACTING THE GROUNDED POWER CONDUCTOR WILL GIVE A READING OF 0 VOLTS WHILE CONTACTING THE UNGROUNDED LEAD WILL GIVE FULL LINE VOLTAGE READING.

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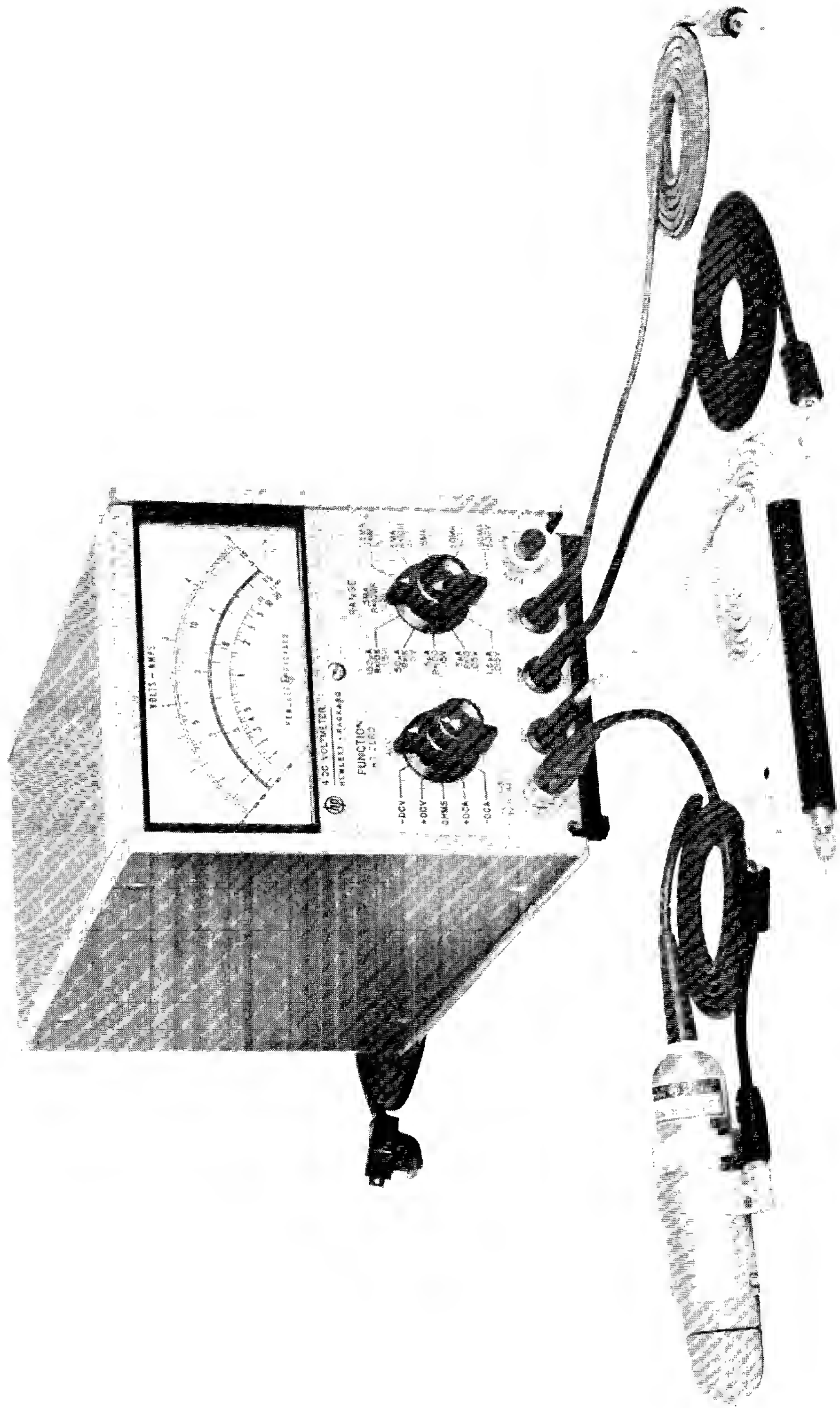

Figure 1-1. The (hp) Model 410C Electronic Voltmeter

Table 1-1. Specifications

DC VOLTMETER

Voltage Range: ±15 mv to ±1500 v full scale in 15, 50, 150 sequence (11 ranges).

Accuracy: ±2% of full scale on any range.

Input Resistance: 100 megohms ±1% on 500 mv range and above. 10 megohms ±3% on 15 mv, 50 mv, and 150 mv ranges.

DC AMMETER

Current Ranges: ±1.5 μa to ±150 ma full scale in 1.5, 5, 15 sequence (11 ranges).

Accuracy: ±3% of full scale on any range.

Input Resistance: Decreasing from 9 k ohms on 1.5 μa scale to approximately 0.3 ohms on the 150 ma scale.

Special Current Ranges: ±1.5, ±5, and ±15 nanoamps full scale may be measured on the 15, 50 and 150 millivolt ranges using the Voltmeter Probe, with ±5% accuracy and 10 megohm input resistance.

OHMMETER

Resistance Range: Resistance from 10 ohms to 10 megohms center scale (7 ranges).

Accuracy: Zero to midscale: ±5% of reading or ±2% of midscale, whichever is greater.

±7% from midscale to scale value of 2
±8% from scale value of 2 to 3
±9% from scale value of 3 to 5
±10% from scale value of 5 to 10

AMPLIFIER

Voltage Gain: 100 maximum

AC Rejection: 3 db at 1/2 cps; approximately 66 db at 50 cps and higher frequencies for signals less than 1600 v peak or 30 times full scale, whichever is smaller.

Isolation: Impedance between common and chassis is >10 megohms in parallel with 0.1 μf. Common may be floated up to 400 v dc above the chassis for dc and resistance measurements.

Output: Proportional to meter indication; 1.5 v dc at full scale: maximum current, 1 ma.

Output Impedance: Less than 3 ohms at dc.

Noise: Less than 0.5% of full scale on any range (p-p).

DC Zero Drift: Less than 0.5% of full scale/year at constant temperature. Less than 0.05% of full scale/^{o}C.

Overload Recovery: Recover from 100:1 overload in < 3 seconds.

AC VOLTMETER: (hp Model 11036A AC Probe required).

Ranges: 0.5 v full scale to 300 v in 0.5, 1.5, 5 sequence (7 ranges).

Accuracy: ±3% of full scale at 400 cps for sinusoidial voltages from 0.5 volts to 300 volts. The AC Probe responds to the positive peak-above-average value of signal applied. The instrument is calibrated in rms volts for sine-wave inputs.

Frequency Response: ±2% at 100 mc; ±10% from 20 cps to 700 mc (400 cps reference). Indications to 3000 mc.

Frequency Range: 20 cps to 700 mc.

Input Impedance: Input capacity 1.5 pf; input resistance >10 megohms at low frequencies. At high frequencies impedance drops off due to dielectric loss.

Safety: The probe body is grounded to chassis at all times for safety. All ac measurements are referenced to chassis ground.

Meter: Individually calibrated taut band meter responds to positive peak-above-average. Calibrated in rms volts for sine wave input.

GENERAL

Maximum Input: DC: 100 v on 15, 50 and 150 mv ranges: 500 v on 0.5 to 15 v ranges; 1600 v on higher ranges. AC: 100 times full scale or 450 v peak, whichever is less.

Power: 115 or 230 v ±10%. 50 to 1000 cps, 13 watts (20 watts with hp Model 11036A AC Probe).

Dimensions: 6-17/32 in. (16.5 cm) high, 5-1/8 inches (13.01 cm) wide, 11 in. (27.9 cm) deep behind panel.

Weight: Net 8 lbs (4.0 Kg); shipping approx. 14 lbs. (6.35 Kg).

Accessory Furnished: Detachable power cord. NEMA plug; hp Model 11036A AC Probe.

Option 02: hp Model 410C less AC Probe.

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 410C Electronic Voltmeter can be used to measure DC voltage and DC current; AC voltage and resistance. Positive and negative DC voltages from 10 millivolts to 1500 volts and positive and negative DC currents from 1.5 microamperes to 150 milliamperes can be measured full scale. Resistance from 10 ohms to 10 megohms full scale can be measured with an accuracy of ±5% of reading at midscale; resistance from 0.2 ohms to 500 megohms can be measured with reduced accuracy. The Model 410C Electronic Voltmeter is shown in Figure 1-1; the specifications are given in Table 1-1.

1-3. With the Model 11036A detachable AC Probe, the Voltmeter can be used to measure AC voltage from 20 cps to 700 Mc. From 20 cps to 100 Mc, AC voltage from 0.5 to 300 volts can be measured; from 100 Mc to 700 Mc, refer to Figure 3-5 for maximum AC voltage that can be applied to the AC Probe. For additional information on the AC Probe, refer to Paragraph 1-8.

1-4. INSTRUMENT IDENTIFICATION.

1-5. Hewlett-Packard uses a two section, eight-digit serial number (000-00000). The serial number is on a plate attached to the rear panel of the instrument. If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, Appendix C, Backdating Changes will define differences between your instrument and the Model 410C described in this manual.

1-6. ACCESSORIES AVAILABLE.

1-7. Accessories are available that extend the AC and DC measuring capabilities of the Voltmeter. A description of these accessories and their specifications is given below.

1-8. MODEL 11036A AC PROBE. This accessory, when used with the Model 410C, permits AC voltage measurements from 0.5 volts rms to 300 volts rms, full scale over a frequency range of 20 cps to 700 Mc. Reference calibration accuracy at 400 cps (sinusoidal) is ±3% of full scale. Frequency response is ±10% from 20 cps to 700 Mc, with indications obtainable to 3000 Mc. Frequency response at 100 Mc is within ±2%. The Model 11036A responds to the positive-peak-above-average value of the signal applied. The Model 410C is calibrated to read in RMS volts, for sine wave inputs.

1-9. MODEL 11039A CAPACITIVE VOLTAGE DIVIDER. This accessory (formerly the Model 452A) extends the AC voltage range of the Model 410C to 25 kv. The divider permits measurements of extremely high AC voltage such as encountered in dielectric heating equipment, etc., over a frequency range of 25 cps to 20 Mc. A fixed gap is provided so that breakdown will occur if the applied voltage exceeds 28 kv at low frequencies. Voltage division is 1000:1, ±3%, and input capacity is 15 picofarads. A Model 11018A Adapter is also required to connect the Model 11036A AC Probe to the shielded banana plug fitting of the divider.

1-10. MODEL 11040A CAPACITY DIVIDER. This accessory (formerly the Model 453A) extends the AC voltage range of the Voltmeter to 2000 volts RMS. The divider is for use at frequencies above 10 kc. Voltage division is 100:1, ±1%, and input capacity is approximately 2 picofarads.

1-11. MODEL 11042A PROBE T CONNECTOR. This accessory (formerly the Model 455A) is used for connecting the Model 11036A Probe across a 50-ohm transmission line using type N connectors. The T-joint is such that connection of the probe into a transmission line will not cause a standing wave ratio greater than 1.1 at 500 Mc and 1.2 at 1000 Mc. With this device, measurement of power traveling through a transmission line may be made with reasonable accuracy to 1000 Mc. The usual precautions must be taken to provide accurate impedance matching and the elimination of standing waves along the line through which power is floating. By using a dummy load at the receiving end of this T-joint, power output of various devices can be measured. In many applications power going into a real load, such as an antenna, can be conveniently measured up to 1000 Mc with good accuracy.

1-12. MODEL 11043A TYPE N CONNECTOR. This accessory (formerly the Model 458A) allows the AC Probe to be connected to a 50-ohm coaxial line. The connector uses a male type N connector and a receptacle for receiving the probe. Terminating resistor is not included.

1-13. MODEL 11045A DC DIVIDER. This accessory extends the maximum DC voltage range of the Model 410C to 30 kv. Voltage division is 100:1, ±5%, and input resistance is 9900 megohms. When used with the Model 410C, input resistance is 10,000 megohms. This probe offers maximum safety and convenience for measuring high voltages such as in television equipment, etc. The maximum current drain is 2.5 microamperes.

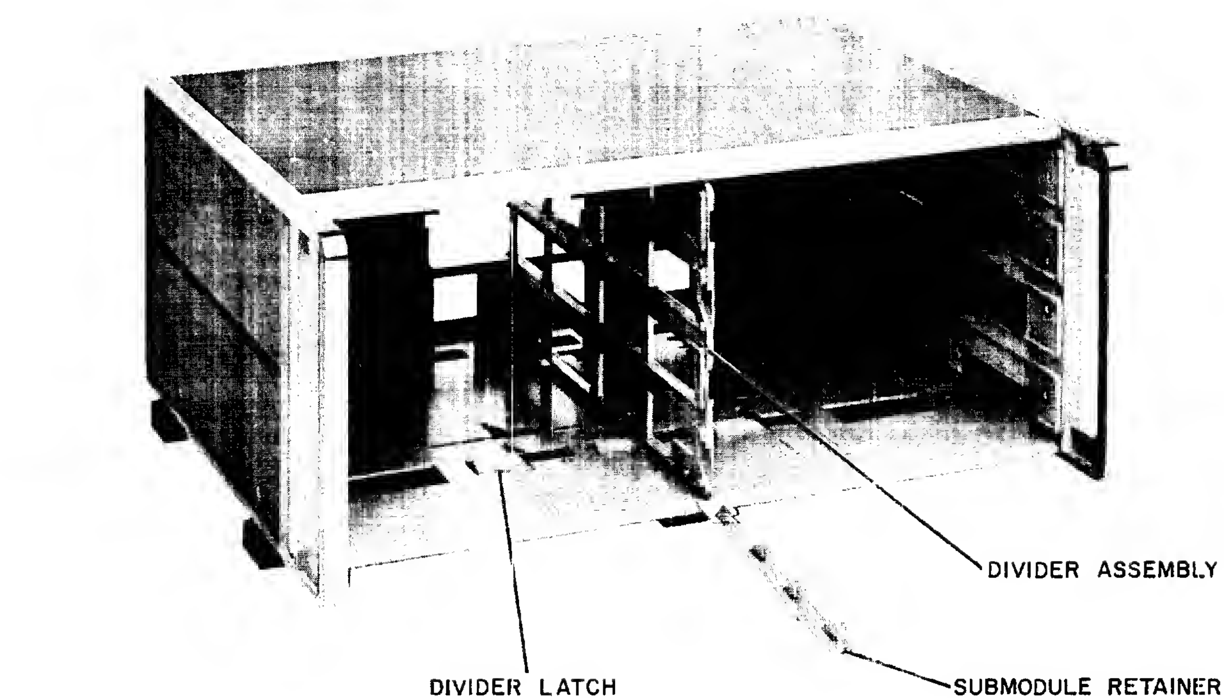

Figure 2-1. The Combining Case

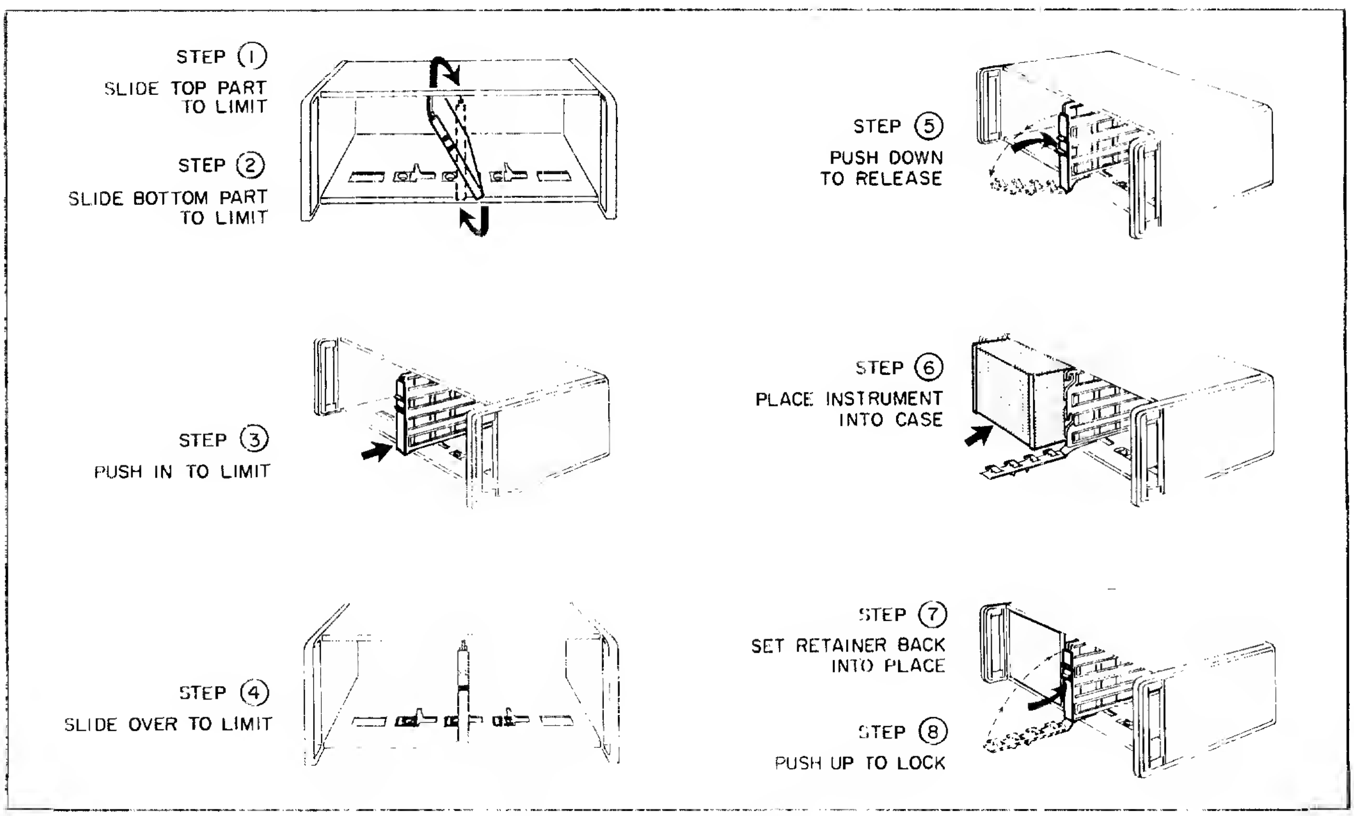

Figure 2-2. Steps to Place Instrument in Combining Case

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SECTION II
INSTALLATION

2-1. INSPECTION.

2-2. This instrument was carefully inspected both mechanically and electrically, before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also, check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Paragraph 5-5, Performance Checks. If there is damage or deficiency, see the warranty on the inside rear cover of this manual.

2-3. INSTALLATION.

2-4. The ⓗⓟ Model 410C is transistorized except for one vacuum tube and requires no special cooling. However, the instrument should not be operated where the ambient temperature exceeds 55° C (140° F).

2-5. RACK MOUNTING.

2-6. The Model 410C is a submodular unit designed for bench use. However, when used in combination with other submodular units, it can be bench and/or rack mounted. The ⓗⓟ Combining Cases and Adapter Frame are designed specifically for this purpose.

2-7. MODELS 1051A AND 1052A COMBINING CASES. The Combining Cases are full-module units which accept various combinations of submodular units. Being a full width unit, it can either be bench or rack mounted. An illustration of the Combining Case is shown in Figure 2-1. Instructions for installing the Model 410C are shown in Figure 2-2.

2-8. RACK ADAPTER FRAME (ⓗⓟ Part No. 5060-0797). The adapter frame is a rack mounting frame that accepts various combinations of submodular units. It can be rack mounted only. An illustration of the adapter frame is given in Figure 2-3. Instructions are given below.

a. Place the adapter frame on edge of bench as shown in step 1, Figure 2-4.

b. Stack the submodular units in the frame as shown in step 2, Figure 2-4. Place the spacer clamps between instruments as shown in step 3, Figure 2-4.

c. Place spacer clamps on the two end instruments (see step 4, Figure 2-4) and push the combination into the frame.

d. Insert screws on either side of frame, and tighten until submodular instruments are tight in the frame.

e. The complete assembly is ready for rack mounting.

2-9. THREE-CONDUCTOR POWER CABLE.

2-10. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cable which grounds the instrument when plugged into an appropriate receptacle.

2-11. To preserve the protection feature when operating the instrument from a two-contact outlet, use three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-12. PRIMARY POWER REQUIREMENTS.

2-13. The Model 410C can be operated from either 115 or 230 volts, 50 to 1000 cps. The instrument can be easily converted from 115- to 230- volt operation. The LINE VOLTAGE switch, S4 a two-position slide switch located at the rear of the instrument, selects the mode of AC operation. The line voltage from which the instrument is set to operate appears on the slider of the switch. A 0.25-ampere, slo-blo fuse is used for both 115- and 230-volt operation.

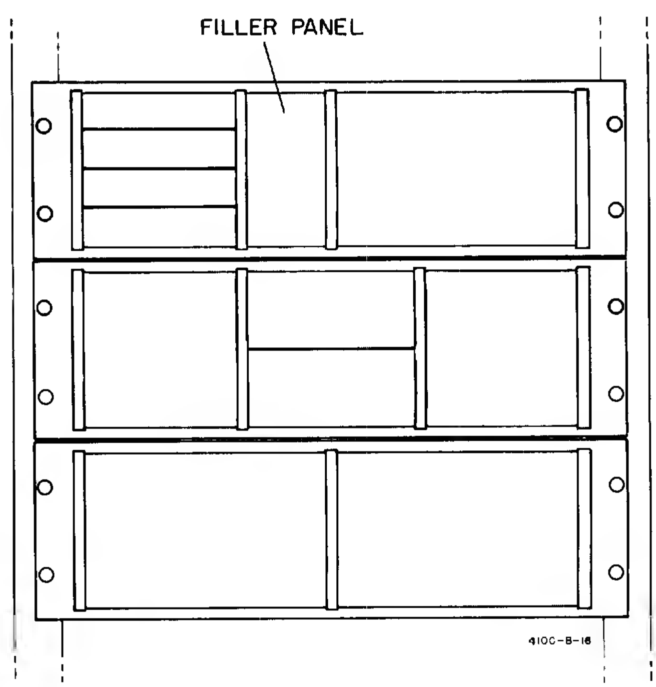

Figure 2-3. Adapter Frame Instrument Combination

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CAUTION

DO NOT CHANGE THE SETTING OF THE LINE VOLTAGE SWITCH WHEN THE VOLTMETER IS OPERATING.

2-14. REPACKAGING FOR SHIPMENT.

2-15. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-16 if the original container is to be used; 2-17 if it is not. If you have any questions, contact your local ⓗⓟ Sales and Service Office. (See Appendix B for office locations.)

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicate the service or repair to be performed; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number and serial number prefix.

2-16. If the original container is to be used, proceed as follows:

a. Place instrument in original container if available. If original container is not available, one can be purchased from your nearest ⓗⓟ Sales and Service Office.

b. Ensure that container is well sealed with strong tape or metal bands.

2-17. If original container is not to be used, proceed as follows:

a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of instrument and protect panel face with cardboard strips.

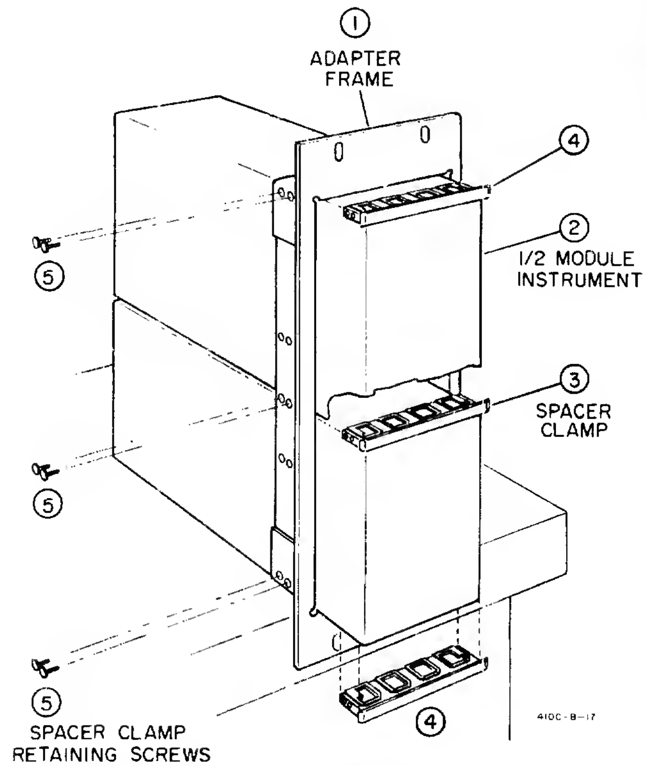


Figure 2-4. Two Half Modules in Rack Adapter

c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark shipping container with "DELICATE INSTRUMENT", "FRAGILE", etc.

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. The Model 410C is used to measure AC and DC voltage, DC current, and resistance. All measurement inputs are located on the front panel; a DC output connector is located on the rear panel. Front panel controls and indicators are color coded. DC voltage, DC current and resistance knobs and indicators are in black; AC voltage controls and indicators are in red.

3-3. ADJUSTMENT OF MECHANICAL ZERO.

3-4. The procedure for adjustment of mechanical zero is given in Section V.

3-5. FRONT AND REAR PANEL DESCRIPTION.

3-6. Figure 3-1 describes the function of all front and rear panel controls, connectors and indicators. The description of each control, connector and indicator is keyed to a drawing which accompanies the figure.

3-7. OPERATING PROCEDURES.

3-8. There are five operating procedures: DC Voltage Measurements, Figure 3-2; DC Current Measurements, Figure 3-3; AC Voltage Measurements, Figure 3-4; Resistance Measurements, Figure 3-7; and Measuring DC Current in Nano-amperes, Figure 3-8.

Note

Ageing of the neon lamps in the chopper assembly can cause a change in chopper frequency which produces a slight oscillatory movement of meter pointer. If this oscillatory movement is observed, rotate Osc Freq Adj A3R5 (see Paragraph 5-28) in the ccw direction until oscillation of pointer stops.

3-9. DC VOLTAGE MEASUREMENTS (Figure 3-2).

3-10. The Model 410C is normally floating; however a shorting bar can be connected at the DC AMPLIFIER OUTPUT connector on the rear panel. When the instrument is floating, the COM Lead should not be connected to voltages greater than 400 volts.

3-11. DC CURRENT MEASUREMENTS (Figure 3-3).

3-12. General instructions for the measurement of DC current are the same as those given for DC voltage measurements, Paragraph 3-9.

3-13. AC VOLTAGE MEASUREMENTS (Figure 3-4).

CAUTION

ONE SIDE OF ALMOST ALL POWER DISTRIBUTION SYSTEMS IS GROUNDED. EXTREME CAUTION MUST BE USED IF DIRECT MEASUREMENT OF POWER LINE VOLTAGES IS ATTEMPTED. IF THE GROUND CLIP LEAD IS ACCIDENTALLY CONNECTED TO THE UNGROUNDED SIDE OF THE LINE. SEVERE DAMAGE TO THE 410C IS POSSIBLE BECAUSE OF THE SHORT CIRCUIT CREATED. POWER LINE VOLTAGES CAN BE SAFELY MEASURED BY USING THE PROBE TIP ONLY. CONTACTING THE GROUNDED POWER CONDUCTOR WILL GIVE A READING OF 0 VOLTS WHILE CONTACTING THE UNGROUNDED LEAD WILL GIVE FULL VOLTAGE READING.

3-14. Although the Model 410C indicates a full scale AC range of 500 volts, the optional Model 11036A AC Probe should not be connected to AC voltages in excess of 300 volts RMS. AC voltage referenced to a DC voltage may be measured, but the AC Probe clip (alligator type) must be connected to the ground (⏚) of the circuit under test.

CAUTION

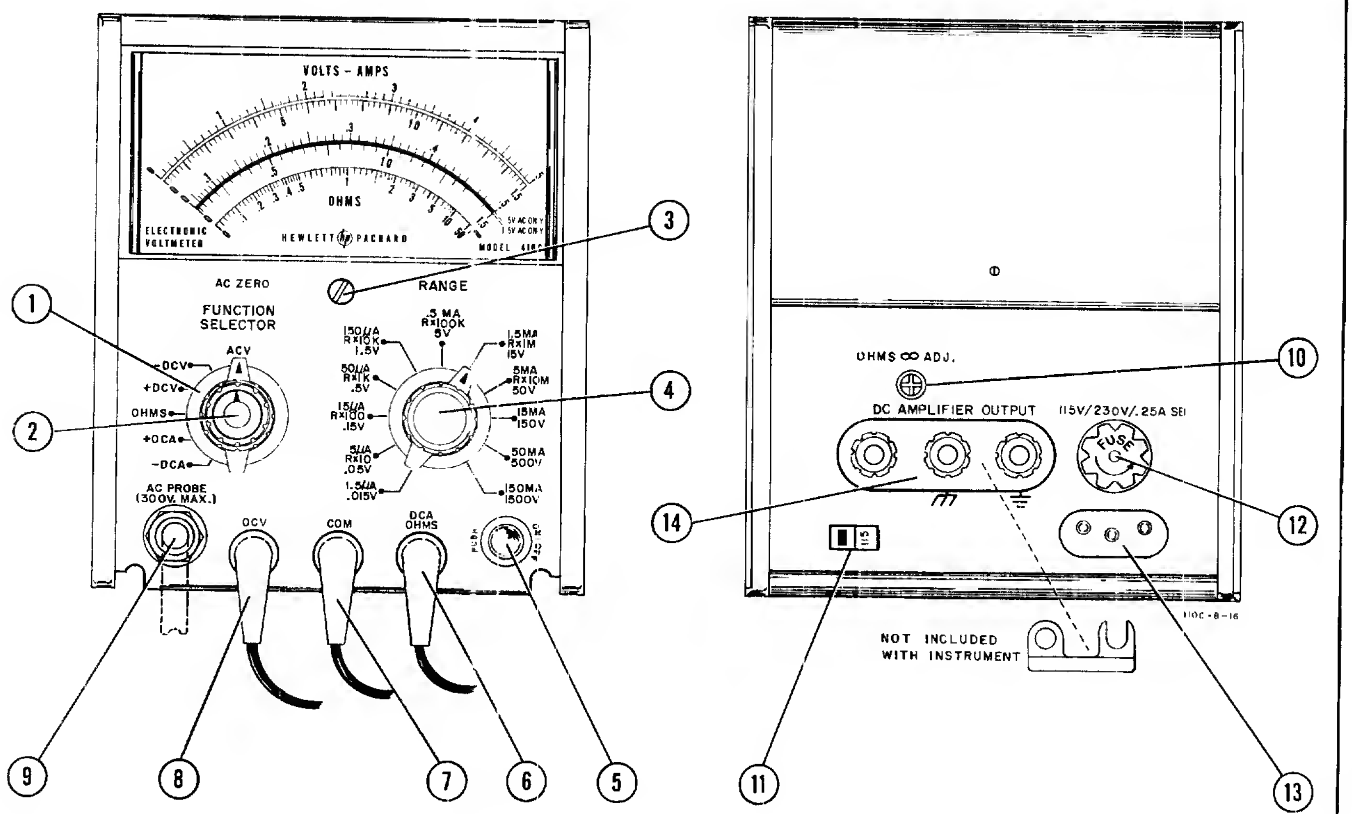
WHEN MEASURING AC REFERENCED TO DC, THE PEAK AC VOLTAGE PLUS DC VOLTAGE CONNECTED TO THE PROBE MUST NOT EXCEED 420 VOLTS.

3-15. PRECAUTIONS WHEN MEASURING AC VOLTAGE.

3-16. Special considerations must be kept in mind when making AC voltage measurements. These considerations are discussed in the following paragraphs.

3-17. GENERAL CONSIDERATION OF COMPLEX WAVEFORMS. Waveforms containing appreciable harmonics or spurious voltages will introduce error in the meter indication since the meter has been calibrated to read RMS values of true sine waves while the Model 11036A Probe is a peak-above-average responding device. The magnitude of error that may be expected when harmonics are present on the measured waveform is indicated in Table 3-1.

3-18. VOLTAGE MEASUREMENTS AT FREQUENCIES BELOW 50 CYCLES/SECOND. Voltage measurements at frequencies as low as 10 cycles per



1. FUNCTION SELECTOR: This control is used for selecting type of measurement to be made. They are: ±DC Voltage, ±DC Current, AC Voltage, and resistance measurements.

2. AC ZERO: This control provides adjustment for zero-setting the meter before making AC voltage measurements.

3. MECHANICAL ZERO ADJUST: This adjustment mechanically zero-sets the meter prior to turning on Voltmeter.

4. RANGE: This control selects the full scale meter range.

5. AC POWER SWITCH: This push button - lamp combination, when depressed, turns the instrument power on or off. The push button glows when the Voltmeter power is on.

6. DCA-OHMS: This lead is used in conjunction with the COM Lead to measure DC current or ohms. The FUNCTION SELECTOR determines which measurement is made.

7. COM: This lead is used with the input leads for DC voltage current, AC voltage, and resistance measurements. The COM Lead is normally floating; however, a shorting bar can be connected from the floating ground terminal to the chassis ground terminal on the DC AMPLIFIER OUTPUT connector. If a shorting bar is not used, the COM Lead is floating except when the FUNCTION SELECTOR is set to ACV.

8. DCV: This lead is used in conjunction with the COM Lead to measure ±DC voltage.

9. AC PROBE (300V MAX): Receptacle for telephone-type plug of Model 11036A AC Probe. With probe connected the Voltmeter may be used to make AC voltage measurements.

10. ∞ ADJUST: This control is used to set meter pointer to ∞ before resistance measurements are made. Only periodic adjustment of this screwdriver adjustment is necessary.

11. LINE VOLTAGE: This two-position slide switch sets the instrument to accept either 115 or 230 volt AC primary power.

12. FUSEHOLDER: The fuseholder contains a 0.25 ampere slow-blow fuse for both 115 vac and 230 vac modes of operation.

13. AC POWER CONNECTOR: Accepts power cable supplied with the instrument.

14. DC AMPLIFIER OUTPUT: Provides DC voltage output proportional to meter indication for driving external recorder. 1.5 volts DC output for full scale meter deflection.

Figure 3-1. Front and Rear Panel Controls

second may be made without loss of accuracy by removing the plastic nose on the Model 11036A and using in its place a 0.25 microfarad blocking capacitor in series with the exposed contact of the probe.

CAUTION

THE GRAY INSULATING MATERIAL AROUND THE AC PROBE IS POLYSTYRENE, A LOW-MELTING POINT MATERIAL. IT IS NOT POSSIBLE TO SOLDER TO THE CONTACT WHICH IS EXPOSED WITH THE PROBE NOSE IS REMOVED WITHOUT DESTROYING THE POLYSTYRENE.

Table 3-1. Possible Error When Measuring Voltage of Complex Waveforms

% Harmonic	True RMS Value	Voltmeter Indication
0	100	100
10% 2nd	100.5	90 to 110
20% 2nd	102	80 to 120
50% 2nd	112	75 to 150
10% 3rd	100.5	90 to 110
20% 3rd	102	87 to 120
50% 3rd	112	108 to 150

3-19. VOLTAGE MEASUREMENT AT HIGH FREQUENCIES. At frequencies above 100 megacycles the distance between the point of voltage measurement and anode of the probe diode must be made as short as possible. If feasible, substitute a small disc type capacitor of approximately 50 picofarads for the removable tip on the probe. Solder one terminal of the button capacitor to the measurement point in the circuit and not to the probe contact. The probe contact (with tip removed) can then contact the other terminal of the capacitor for the measurement.

3-20. At frequencies above 100 megacycles considerable voltage may be built up across ground leads and along various part of a grounding plane. Consequently, to avoid erroneous readings when measuring medium and high frequency circuits, use the ground clip lead on the shell of the probe to connect the circuit ground. In some cases at the higher frequencies it may be necessary to shorten the grounding lead on the probe.

3-21. For all measurements at higher frequencies, hold the molded nose of the probe as far from the external ground plane or from object at ground potential as can conveniently be done. Under typical conditions, this practice will keep the input capacitance several tenths of a picofarad lower than otherwise.

3-22. For measurements above approximately 250 megacycles it is almost mandatory that measurements be made on voltages which are confined to coaxial transmission line circuits. For applications of this type, the Model 11036A Probe is particularly suitable because the physical configuration of the diode and probe is that of a concentric line, and with a few precautions it can be connected to typical coaxial transmission line circuits with little difficulty.

3-23. To connect the probe into an existing coaxial transmission line, cut the line away so the center conductor of the line is exposed through a hole large enough to clear the body of the probe. The nose of the probe should be removed for this type of measurement. Connect one terminal of a button-type capacitor of approximately 50 picofarads to the center conductor of the coaxial line so that the other terminal of the capacitor will contact the anode connection of the probe. A close-fitting metal shield or bushing should be arranged to ground the outer cylinder of the probe to the outer conductor of the transmission line. This type of connection is likely to cause some increase in the standing wave ratio of the line at higher frequencies. The Model 11042A Probe T Connector is designed to do this job with SWR or less than 1.1 at 500 Mc (see Paragraph 1-11).

3-24. EFFECT OF PARASITICS ON VOLTAGE READINGS. At frequencies above 500 megacycles, leads or portions of circuits often resonate at frequencies two, three, or four times the fundamental of the voltage being measured. These harmonics may cause serious errors in the meter reading. Owning to the resonant rise in the probe circuit at frequencies above 1000 megacycles, the meter may be more sensitive to the harmonics than to the fundamental. To make dependable measurements at these frequencies, the circuits being measured must be free of all parasitics.

3-25. EFFECT OF DC PRESENT WITH AC SIGNAL. When measuring an AC signal at a point where there is a high DC potential, such as at the plate of a vacuum tube, the high DC potential may cause small leakage current through the blocking capacitor in the tip of the Model 11036A AC Probe. When the AC signal under measurement is small, the error introduced into the reading can be significant. To avoid leakage, an additional capacitor with a dielectric such as mylar or polystyrene which has high resistance to leakage is required. (Use 5 picofarads or higher, and insert the capacitor between the point of measurement and the probe tip.)

3-26. PULSE MEASUREMENTS.

3-27. POSITIVE PULSES. The Model 11036A AC Probe is peak-above-average responding and clamps the positive peak value of the applied voltage. This permits the probe to be used to measure the positive-voltage amplitude of a pulse, provided the reading obtained is multiplied by a factor determined from the following expression:

$$1.4\left(1 + \frac{t_1}{t_2} + \frac{K}{PRF}\right)$$

t_1 is the duration of the positive portion of the voltage in microseconds.

t_2 is the duration of the negative portion of the voltage in microseconds.

K is a factor determined from the expression R_0/t_1 and the graph shown as Figure 3-6, where R_0 is the source impedance of the pulse generator in kilohms, and t_1 is the duration of the positive portion of the pulse in microseconds.

PRF is the pulse repetition frequency in pulses per second (pps).

Suppose, for example:

t_1 = 10 microseconds

t_2 = 990 microseconds

K = 0.55

PRF = 1000 pps

To find K, assuming R_0 = 2 kilohms and t_1 = 10 microseconds: R_0/t_1 = 2/10° = 0.2. Location 0.2 on the X axis of the graph shown as Figure 3-6, and reading K where X and Y axes intersect the unmarked curve. If the ratio of R_0/t_1 were greater than 1, multiply the X and Y axes by 10, and use the curve marked "R_0/t_1 and K each X10".

Solving the expression for the multiplying factor,

$$1.4 \quad 1 + \left(\frac{10}{990} + \frac{0.55}{1000}\right) =$$

$$1.4\ (1 + 0.01 + 0.00055) =$$

$$1.4\ (1.01055) =$$

$$1.41477$$

3-28. NEGATIVE PULSES.

3-29. In the case of a 10 microsecond negative pulse (t_2) and a pulse repetition frequency (PRF) of 1000 pps, t_1 would be 990 microseconds. Thus T_0/t_1 would be approximately 0, and from the graph it is seen that K is approximately 0. The expression would then reduce to

$$1.4 \quad \left(1 + \frac{990}{10}\right)$$

3-30. It can be seen that in the case of negative pulses of short duration much smaller readings will be obtained for an equivalent positive pulse. As a result, large multiplying factors must be used and unless the pulse voltage is large, these measurements may be impractical.

3-31. MEASURING RESISTANCE (Figure 3-7).

3-32. Before making resistance measurements, power must be removed from the circuit to be tested. Also, make sure capacitors are discharged to eliminate any residual voltage.

3-33. MEASURING DC NANO-AMPERE CURRENT (Figure 3-8).

3-34. The Model 410C can be used to measure nano-ampere leakage current in transistors and diodes. The three most sensitive DC voltage measurement ranges are used to measure DC nano-ampere currents.

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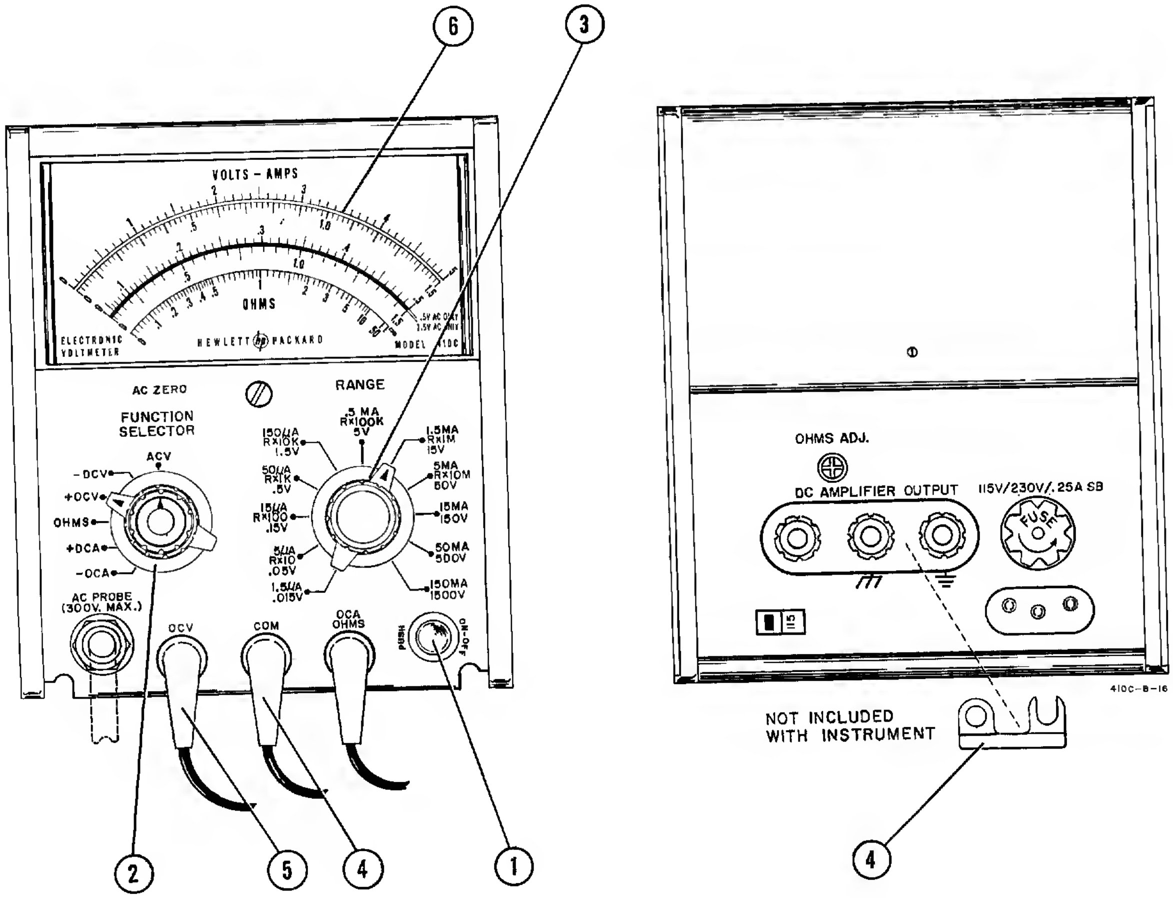


1. Depress the AC power switch (neon- switch combination).
2. Set FUNCTION SELECTOR to polarity desired (+DCV or -DCV).
3. Set RANGE to desired voltage position.
4. Connect COM Lead to the ground of circuit under test. Do not connect common lead to voltages greater than 400 volt when making off-cabinet-ground connections.

WARNING

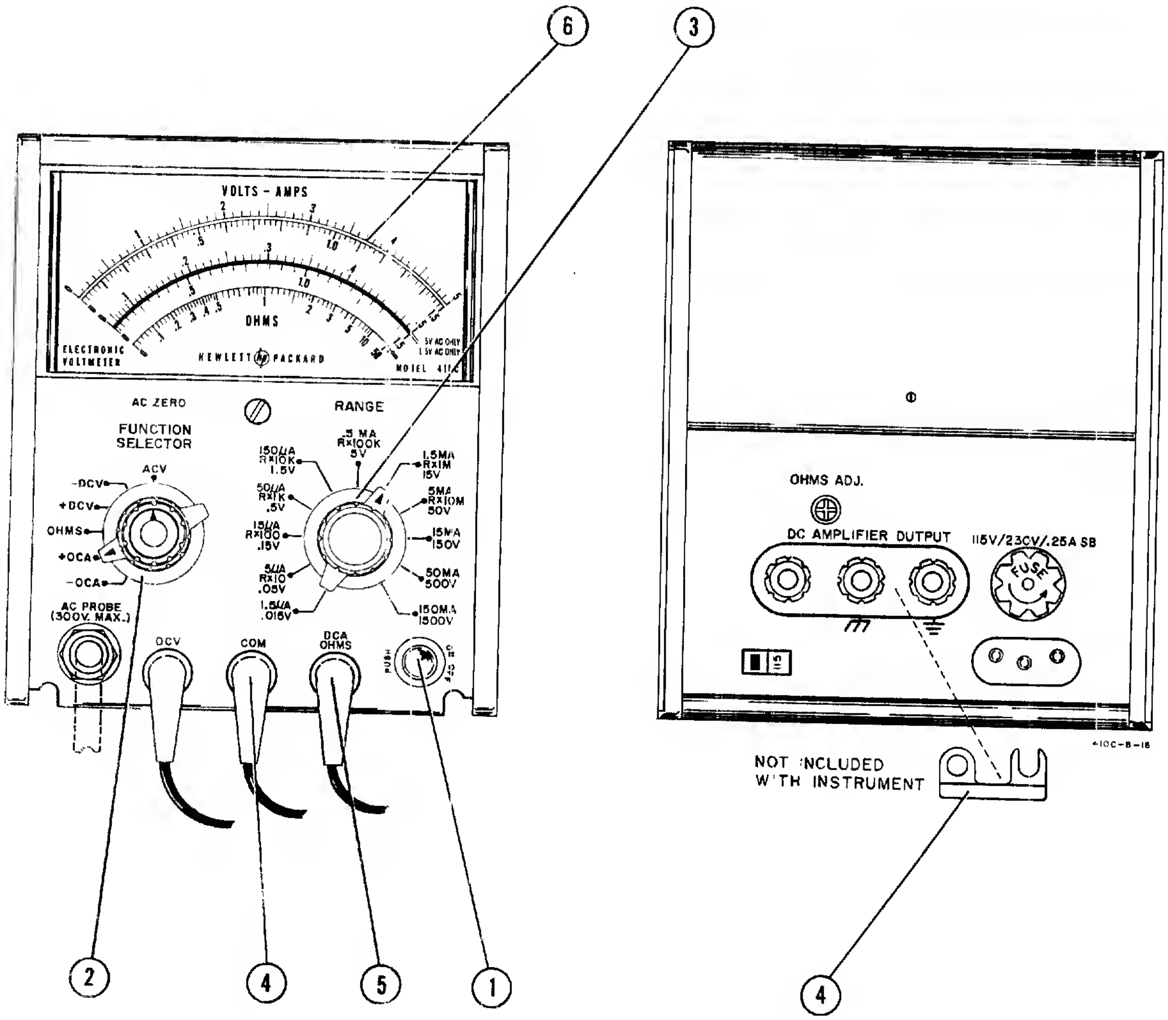
WHEN MEASURING POTENTIALS REFERENCED TO VALUES OFF GROUND, REMOVE SHORTING STRAP FROM DC AMPLIFIER OUTPUT CONNECTOR ON REAR PANEL. IF THE SHORTING STRAP IS NOT REMOVED, THE INSTRUMENT CABINET IS TIED TO THE COMMON LEAD. NORMALLY, FOR SAFETY, THE CABINET IS ALSO TIED TO EARTH GROUND THROUGH THE THIRD WIRE TO THE THREE-PRONG CONNECTOR. IF THIS THIRD WIRE CONNECTION WERE REMOVED (BY USING AN ADAPTING PLUG) THE CABINET WILL ASSUME AN ELEVATED POTENTIAL.

5. Touch DCV probe to test point.
6. Read voltage on the VOLTS-AMPS scale.

Note

Ageing of the neon lamps in the chopper assembly can cause a change in chopper frequency which produces a low amplitude oscillatory movement of the meter pointer. If the meter pointer oscillates, rotate A3R5 ccw until oscillation stops.

Figure 3-2. DC Voltage Measurements



1. Depress the AC power switch (neon-switch combination).

2. Set FUNCTION SELECTOR to the polarity desired (+DCA or -DCA).

3. Set range to desired current position.

4. Connect COM Lead to the ground of circuit under test. Do not connect common lead to voltages greater than 400 volts, when making off-cabinet ground connections.

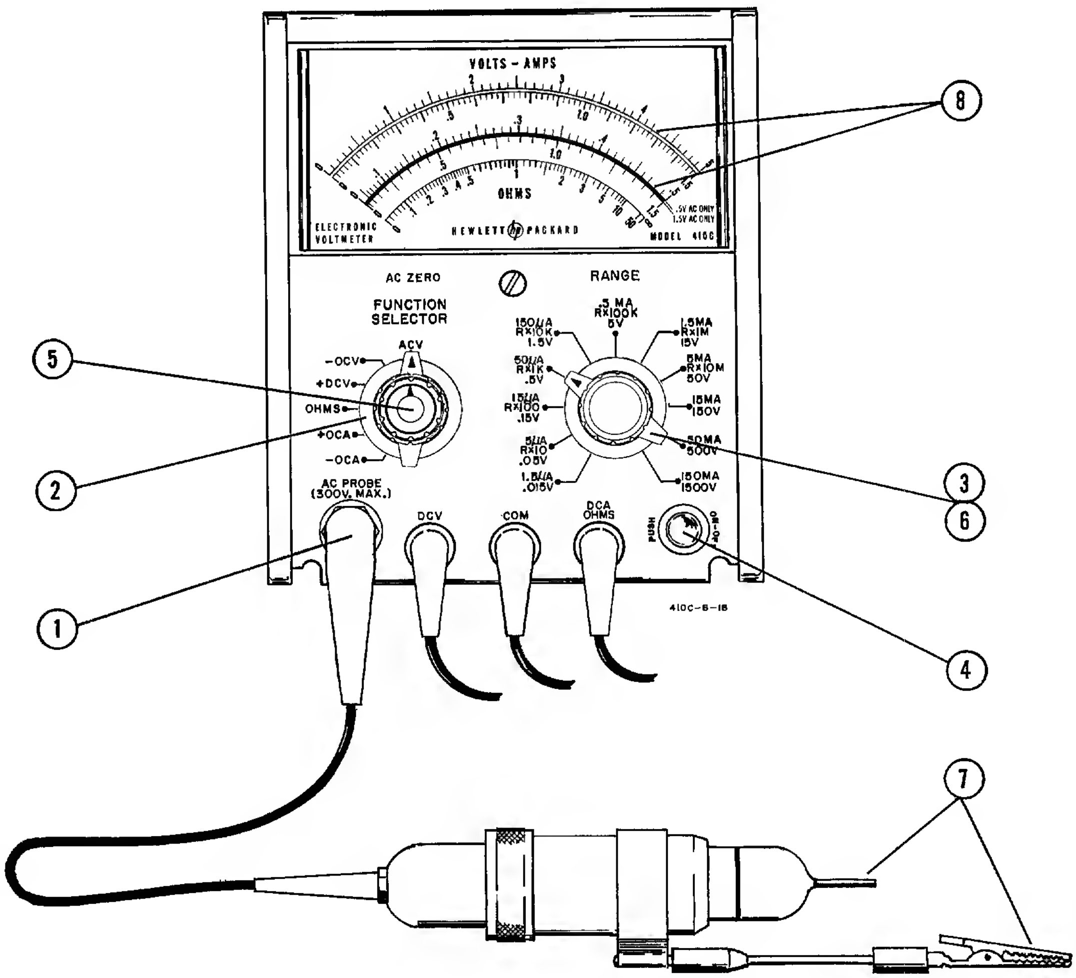
WARNING

IF THE SHORTING STRAP IS NOT REMOVED, THE INSTRUMENT CABINET IS TIED TO THE COMMON LEAD. NORMALLY FOR SAFETY, THE CABINET IS ALSO TIED TO EARTH GROUND THROUGH THE THIRD WIRE TO THE THREE-PRONG CONNECTOR. IF THIS THIRD WIRE CONNECTION WERE REMOVED (USING A TWO PRONG-TO-THREE PRONG ADAPTER), THE CABINET WILL BE AT AN ELEVATED POTENTIAL.

5. Connect the DCA ohms probe to the circuit to be tested.

6. Read the current on the VOLTS-AMPS scale.

Figure 3-3. DC Current Measurements



CAUTION

CONNECT AC PROBE CLIP TO EARTH GROUND ONLY.

1. Connect the hp Model 11036A AC Probe to the Model 410C at the AC PROBE receptacle.
2. Set FUNCTION SELECTOR to ACV. NOTE: COM and chassis are internally connected when the FUNCTION SELECTOR is set to ACV.
3. Set RANGE to .5V.
4. Depress the AC power button (neon-switch combination) and allow 5 minute warmup.
5. Adjust AC ZERO for a zero indication on the meter.
6. Set RANGE to the desired voltage range.
7. Connect AC Probe clip (alligator) to ground of circuit to be tested, and touch probe tip to test point. At lower frequencies COM Lead can be substituted for the AC probe clip.

CAUTION

BEFORE MEASURING VOLTAGES AT FREQUENCIES ABOVE 100 MC, REFER TO FIGURE 3-5, TO DETERMINE THE MAXIMUM AMOUNT OF VOLTAGE THAT CAN BE APPLIED AT THAT FREQUENCY.

8. Read AC voltage on the VOLTS-AMPS scale. NOTE: When RANGE is on the .5V and 1.5V positions, use red meter scale.

Figure 3-4. AC Voltage Measurements

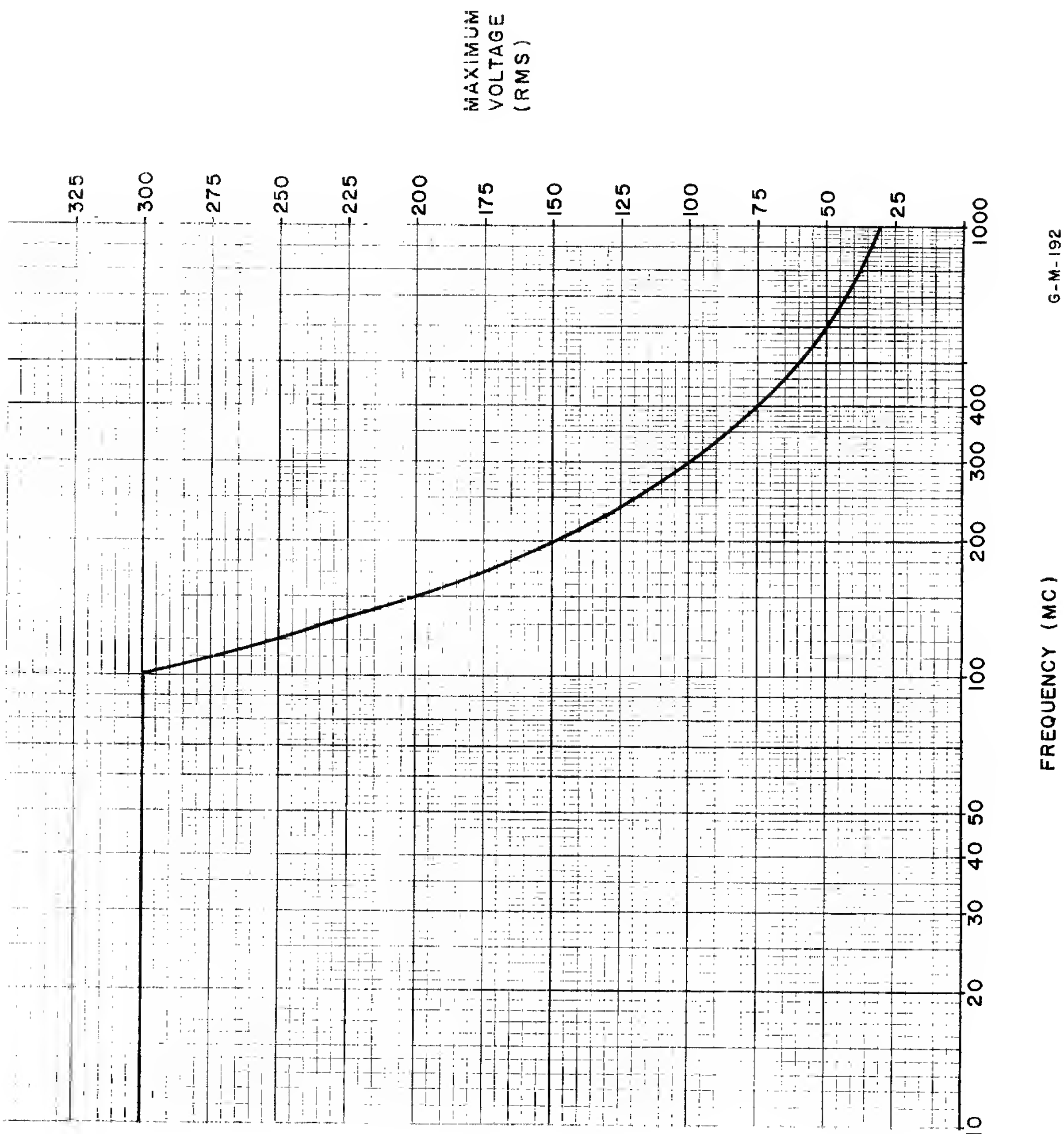


Figure 3-5. Maximum AC Voltage Chart for 11036A AC Probe

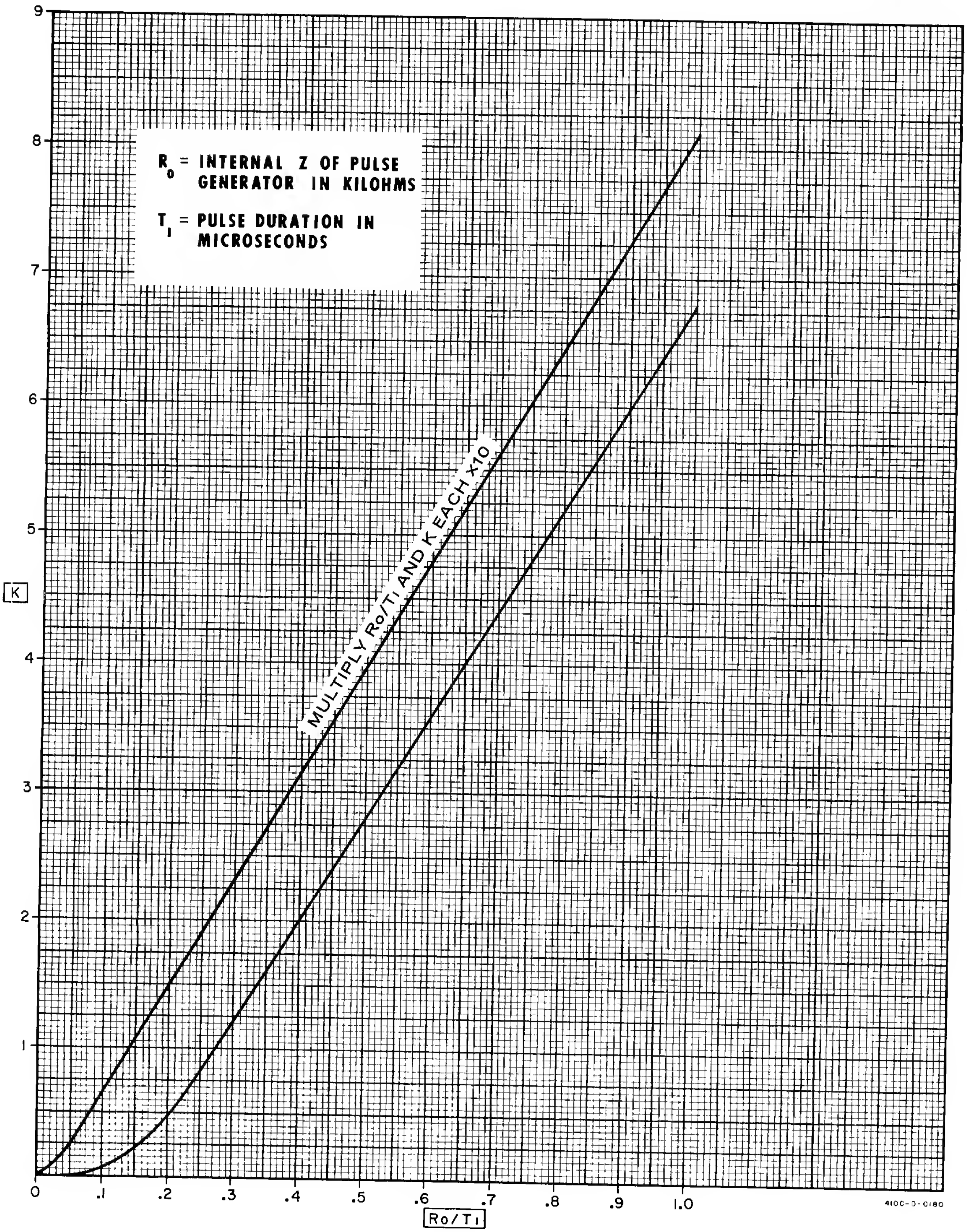


Figure 3-6. Graph Used in Calculation of Pulse Voltage Readings

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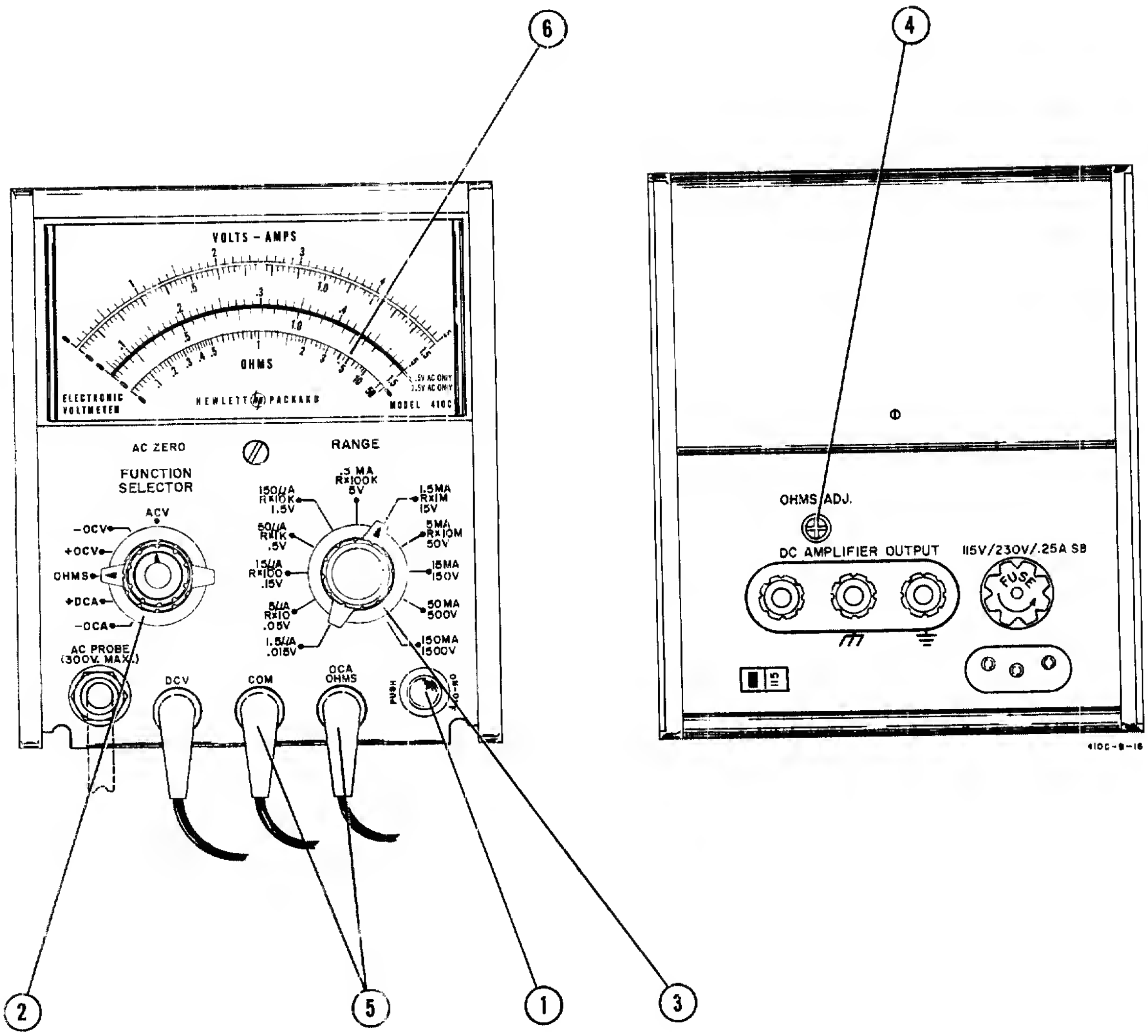
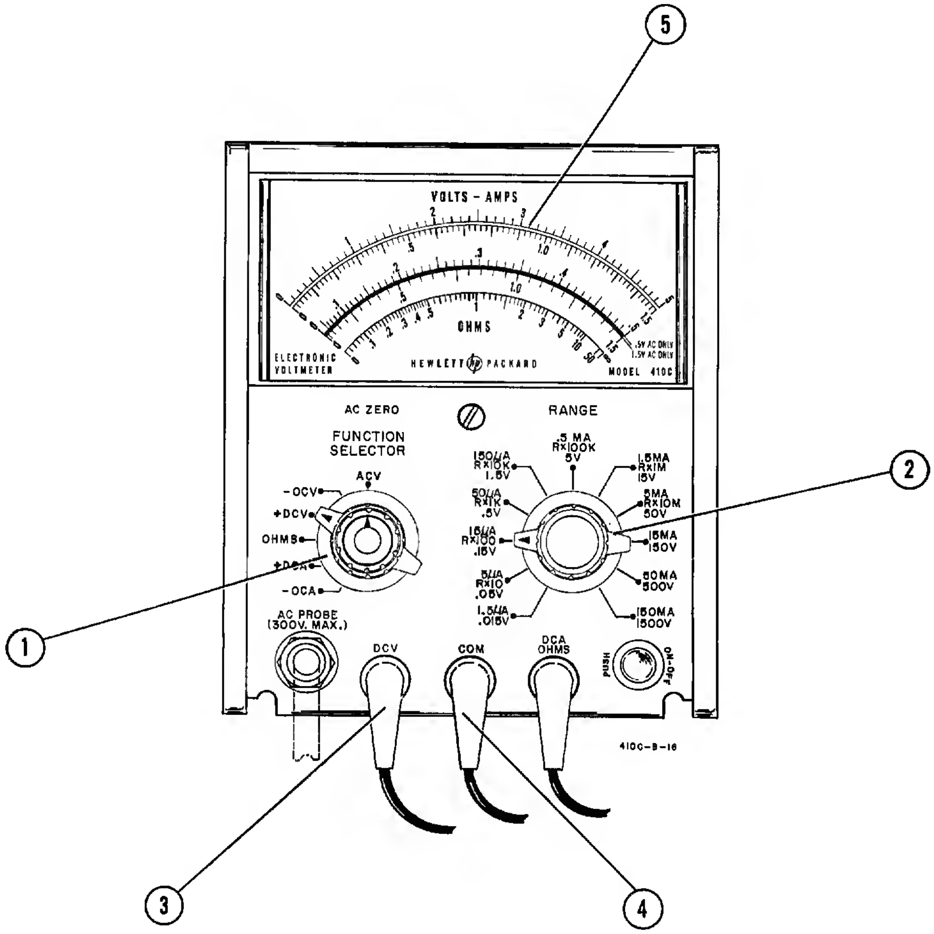


Before making resistance measurements, remove power from circuit to be tested. Be sure to discharge capacitors to eliminate any residual voltage.

1. Depress AC power switch (neon-switch combination).
2. Set the FUNCTION SELECTOR to OHMS.
3. Set RANGE to desired position.
4. Adjust OHMS ∞ ADJ. control on rear panel to obtain an ∞ reading on the meter if necessary.
5. Connect COM and DCA OHMS leads across circuit to component to be tested.
6. Resistance is determined by multiplying the reading on the OHMS scale by the RANGE factor. EXAMPLE: If reading is 1.5 and factor is 10K, then resistance equals 15K ohms.

Figure 3-7. Resistance Measurements



1. Set the FUNCTION SELECTOR to +DCV or -DCV (depending on direction of current flow).
2. Set RANGE to desired range (.015V, .05V, or .15V range).

Note

0.015V range = 1.5 nano-amperes range
0.05V range = 5.0 nano-amperes range
0.15V range = 15 nano-amperes range

3. Connect the DCV lead to the circuit under test.
4. Connect the COM lead to the circuit under test.
5. Read nano-amperes from the meter on the VOLTS-AMPS scale (top two on meter) which corresponds to the range selected.

Figure 3-8. DC Nano-Ampere Current Measurements

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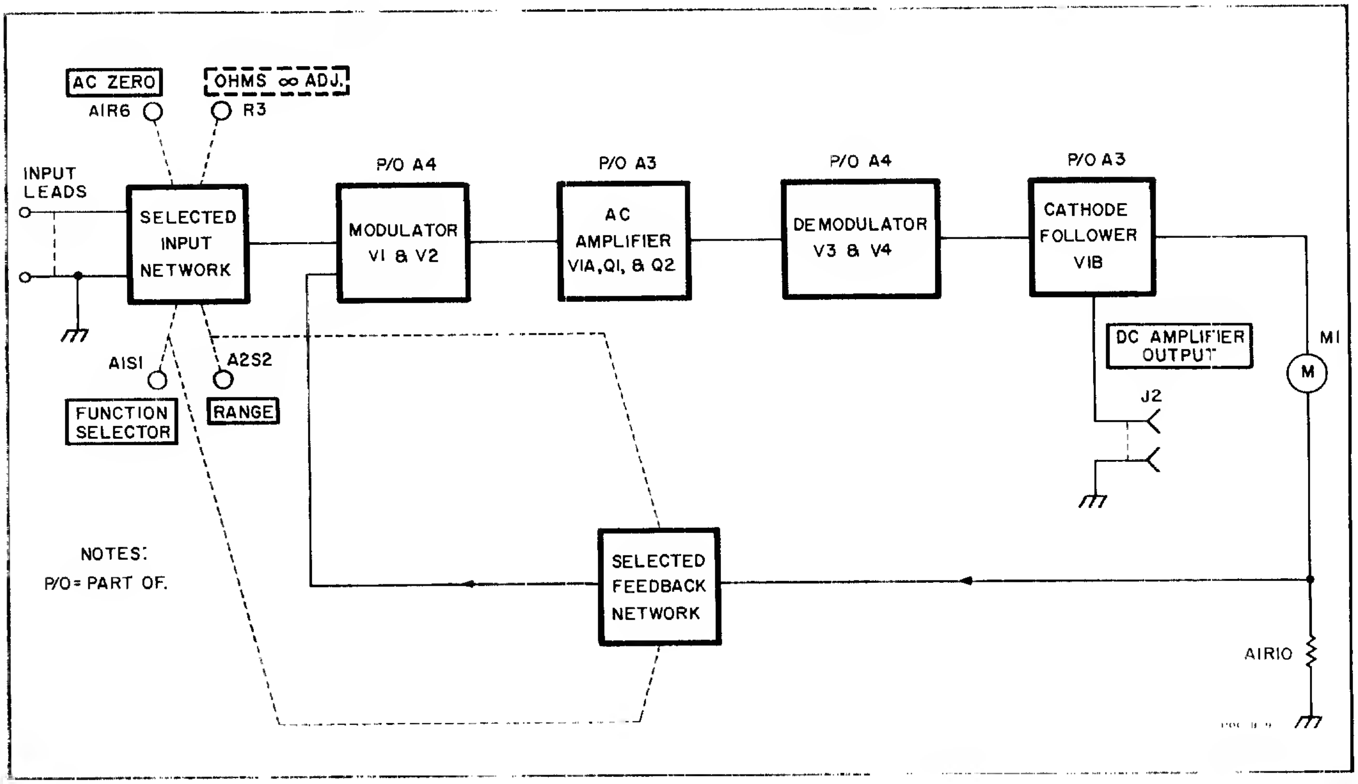

Figure 4-1. Block Diagram, Model 410C

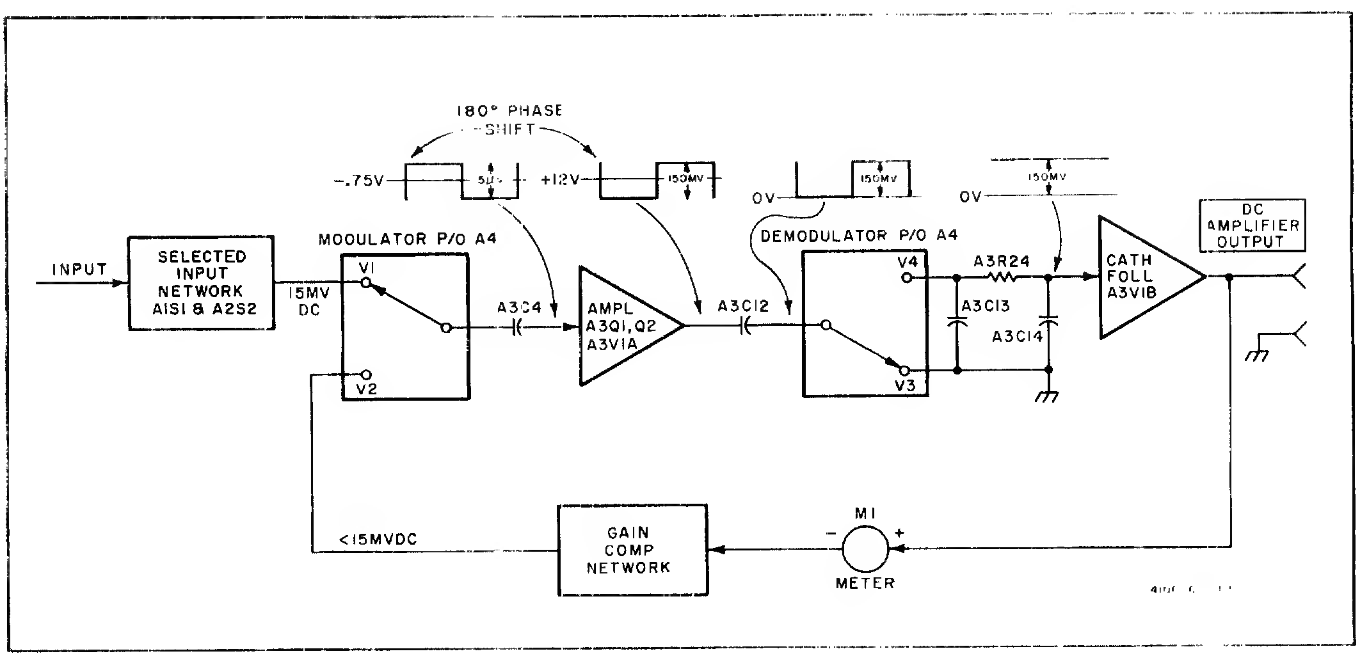

Figure 4-2. Modulator-Demodulator Mechanical Analogy

SECTION IV
THEORY OF OPERATION

4-1. OVERALL DESCRIPTION.

4-2. The Model 410C includes an input network, a modulator-amplifier-demodulator, and a meter circuit. A block diagram of the Model 410C is shown in Figure 4-1.

4-3. Signals to be measured are applied through the appropriate input lead to the input network. AC voltages are detected in the AC probe, and therefore all signals to the input network are DC. The input network attenuates the DC signal to a level determined by RANGE and FUNCTION SELECTOR settings. The attenuated DC voltage is applied to the modulator which converts the DC to AC for amplification. The amplified AC signal is converted back to DC voltage in the demodulator and coupled to cathode follower V1B. The cathode follower output to the DC AMPLIFIER OUTPUT connector and meter circuit is a DC voltage proportional to the amplitude of the signal applied to the input. A portion of the voltage to the meter circuit is returned to the modulator as feedback. When the feedback voltage and attenuated DC voltage are nearly equal, the meter stabilizes.

4-4. CIRCUIT DESCRIPTION.

4-5. INPUT NETWORK.

4-6. The input network includes a precision voltage divider, which by means of the FUNCTION SELECTOR and RANGE switches, provides a maximum of 15 millivolts at the modulator input regardless of the range set and signal applied. The ±DCA, ±DCV, OHMS, and ACV modes of operation are discussed below.

4-7. DC CURRENT MEASUREMENTS: Refer to Figure 4-3, throughout this explanation. The purpose of the input network is to provide proper attenuation of currents applied. Currents from 1.5 μa to 150 ma full scale are applied with input impedance decreasing from 9K ohms on the 1.5 μa range to approximately 0.3 ohms on the 150 ma range.

4-8. The change in input impedance is varied by using DC current shunts in conjunction with RANGE switch A2S2. The DC voltage developed across these shunt resistors, when applied through the modulator-amplifier-demodulator network to the meter, provide a deflection on the meter proportional to the DC current being measured.

4-9. DC VOLTAGE MEASUREMENTS. Refer to Figure 4-4 throughout this explanation. The purpose of the input network is to accurately attenuate the input signal to a maximum of 15 millivolts at the modulator input. The network presents an input impedance of 10 megohms on the three most sensitive ranges and 100 megohms on all other ranges.

4-10. The resistor R1 (located in the DCV probe) in conjunction with resistors A2R10 through A2R26, provides the 10 megohm input impedance required for the three most sensitive DCV ranges. Resistors A2R4 and A3R30 are shunted out of the circuit by the RANGE switch on the three most sensitive DCV ranges.

4-11. When using the eight less sensitive ranges, A2R4 and A3R30 are placed in series with R1 and A2R10 through A2R26 to present more than 100 megohm impedance to the input.

4-12. A3R30 is used to calibrate full scale on the 1500 volt range. (See Paragraph 5-35.)

4-13. RESISTANCE MEASUREMENTS. The purpose of the input network shown in Figure 4-5 is to place approximately 0.6 volt DC source in series with a known (reference) resistance. The resistance to be measured is placed in parallel with the known resistance, which changes the voltage proportionally. The maximum changes in voltage applied to the modulator is 15 mv because of attenuation provided by A2R4, A3R30, and A1R2.

4-14. A DC current of approximately 60 ma is supplied at the junction of A2R22 and A2R23 through A7R10, R2, A2R2 and A2R1 to the input network. The OHMS ∞ ADJ., R3, sets the meter for full scale (∞). Resistor A2R1 is shorted out in the X1M position of the RANGE switch; resistors A2R1 and A2R2 are shorted out in the X10M range. The resistors A2R2 and/or A2R1 are electrically removed from the circuit to increase the voltage at the junction of A2R22 and A2R23. This is done to compensate for the loading of the attenuator (A2R4, A3R30, and A1R2) on these ranges.

4-15. AC VOLTAGE MEASUREMENTS. Refer to Figure 4-6 throughout this explanation. Voltage at the AC probe is converted to DC and applied to the input network. The input signal is attenuated to produce a maximum of about 15 millivolts at the modulator input. AC zero adjustment of meter pointer is made with the AC ZERO control.

4-16. MODULATOR-DEMODULATOR.

4-17. Refer to the Amplifier Schematic, Figure 5-10, and to the Mechanical Analogy Schematic, Figure 4-2 throughout this explanation.

4-18. The input network applies approximately 15 millivolts DC, for full scale meter deflection (positive or negative, depending on the polarity of the

voltage or current being measured) to the neon-photoconductor chopper. Also applied to the opposite side of the chopper is the amplifier feedback voltage, which is of the same polarity and approximately 5 microvolts lower in amplitude than the input voltage. The modulator-chopper consists of two photoconductors, A4V1 and A4V2, which are alternately illuminated by two neon lamps, A4DS1 and A4DS2, respectively. The neon lamps are part of a relaxation oscillator, whose frequency is controlled by A3R5. The oscillator frequency is nominally set to 100 cps for operation from 60 cps power line, or to 85 cps for 50 cps line. This frequency is selected so that it is not harmonically related to the power line frequency, precluding possible beat indications on the meter.

4-19. As the photoconductors are alternately illuminated by the neons, their respective resistances are low (conductive) when illuminated and high (non-conductive) when darkened. Therefore the input voltage and feedback voltage are alternately applied to the input amplifier. The amplitude of the resultant signal to the amplifier is the voltage difference between the input and feedback voltages.

4-20. The chopped DC signal is amplified by a three stage RC amplifier, consisting of A3V1A, A3Q1 and A3Q2. The amplified signal to the input of the demodulator-chopper is 180° out of phase with the output of the modulator-chopper.

4-21. The demodulator - chopper consists of two photoconductors, A4V3 and A4V4, which are alternately illuminated by neon lamps A4DS1 and A4DS2, respectively. Approximately 150 millivolts square-wave is applied to the demodulator from the amplifier. Since the same neon lamps illuminate both the modulator and demodulator photoconductors, operation of the two chopper is synchronous. Therefore, when A4V1 is sampling the input voltage, A4V3 is clamping the amplified and inverted difference voltage to ground. Alternately, when A4V2 is sampling the feedback voltage, A4V4 is charging capacitors A3C13 and A3C14 to the peak value of the square-wave. These capacitors maintain this charge so long as the input voltage remains constant by virtue of having no discharge path and because they are being repetitively recharged by the demodulator.

4-22. Therefore, a DC potential, proportional to the difference between the input and feedback voltages, is applied to the grid of the cathode follower and subsequently to meter circuit and DC AMPLIFIER OUTPUT connector. A portion of the meter circuit voltage is fed back to the modulator. The meter stabilizes when the feedback voltage and input voltages are nearly equal.

4-23. THE FEEDBACK NETWORK.

4-24. The feedback network drives the meter and determines the DC gain of the amplifier. The feedback is varied depending on the position of the FUNCTION and RANGE selectors. The different feedback configurations are discussed below.

4-25. FEEDBACK NETWORK FOR ±DCA, OHMS, AND ±DCV. Figures 4-3, 4-4 and 4-5 show the feedback configuration for all positions of the FUNCTION SELECTOR except ACV. The meter is electrically inverted for ±DCV and ±DCA modes of operation. The DC OUTPUT ADJ., A6R20 sets the output voltage. The DC pot, A6R18 determines the amount of feedback to the modulator. The resistor A2R30 is in the circuit in the ±.015 DCV and ±1.5 μa modes of operation, to decrease feedback and thus increase amplifier gain to compensate for the decrease in input signal to the modulator on these ranges.

4-26. FEEDBACK CIRCUIT FOR AC VOLTAGE MEASUREMENTS: Figure 4-6 shows the feedback configuration for the ACV position of the FUNCTION SELECTOR switch, A2S2. The resistors that are placed in the circuit by the RANGE switch program the amplifier gain to compensate for the non-linear response of the AC probe. A6R16 and A6CR1 compensate the non-linear response of the AC probe to the linear calibration of the upper meter scale on the 5 volt range.

4-27. POWER SUPPLY.

4-28. PRIMARY POWER. Either 115 or 230 volt ac power is connected through fuse R1 (0.25 amp slo-blo) and switch S3 to the primary of power transformer T1. Switch S4 connects T1 primaries in parallel for 115 volt operation of in series for 230 volt operation.

4-29. UNREGULATED AND ZENER REGULATED POWER SUPPLY. Full wave rectifier CR1 and CR2 produces unregulated +270 volts, which is used to drive the photochopper neons. Unregulated +175 volts and +140 volts are tapped off and are used to provide B+ to the plates of A4V1B and A4V1A, respectively. Zener regulators A7CR6 and CR7 provide regulated +38 volts and -9 volts to bias A3Q1 and A3Q2. Filtering of the outputs is provided by the RC network consisting of A7R1 through A7R3 and C5A through C5D.

4-30. SERIES REGULATED POWER SUPPLY. The output of the full wave rectifier CR3 and CR4 is regulated by transistor Q1, which is connected in series with the output. Zener diode A7CR8 provides reference voltage to the base of Q1. Regulated +6 volts is supplied to the filaments of A3V1A/B and the AC Probe diode A8V1. +0.6 volts is provided through A7R10 to R3, the OHMS ∞ ADJ. control. Filtering of the outputs is provided by C6A and C6B.

4-31. STANDBY FILAMENT SUPPLY. The filament tap (T1, Pins 1 and 2) provides 6.0 volts ac to the filament of the AC probe diode, A8V1, so that the filament remains warm when the Model 410C is being used in modes of operation other than ACV. When FUNCTION selector A1S1 is switched to ACV, 6.0 volts AC is removed from the filament and 6 volts DC is applied. Therefore, the ACV mode is ready for immediate use, without waiting for the filament to warm up.

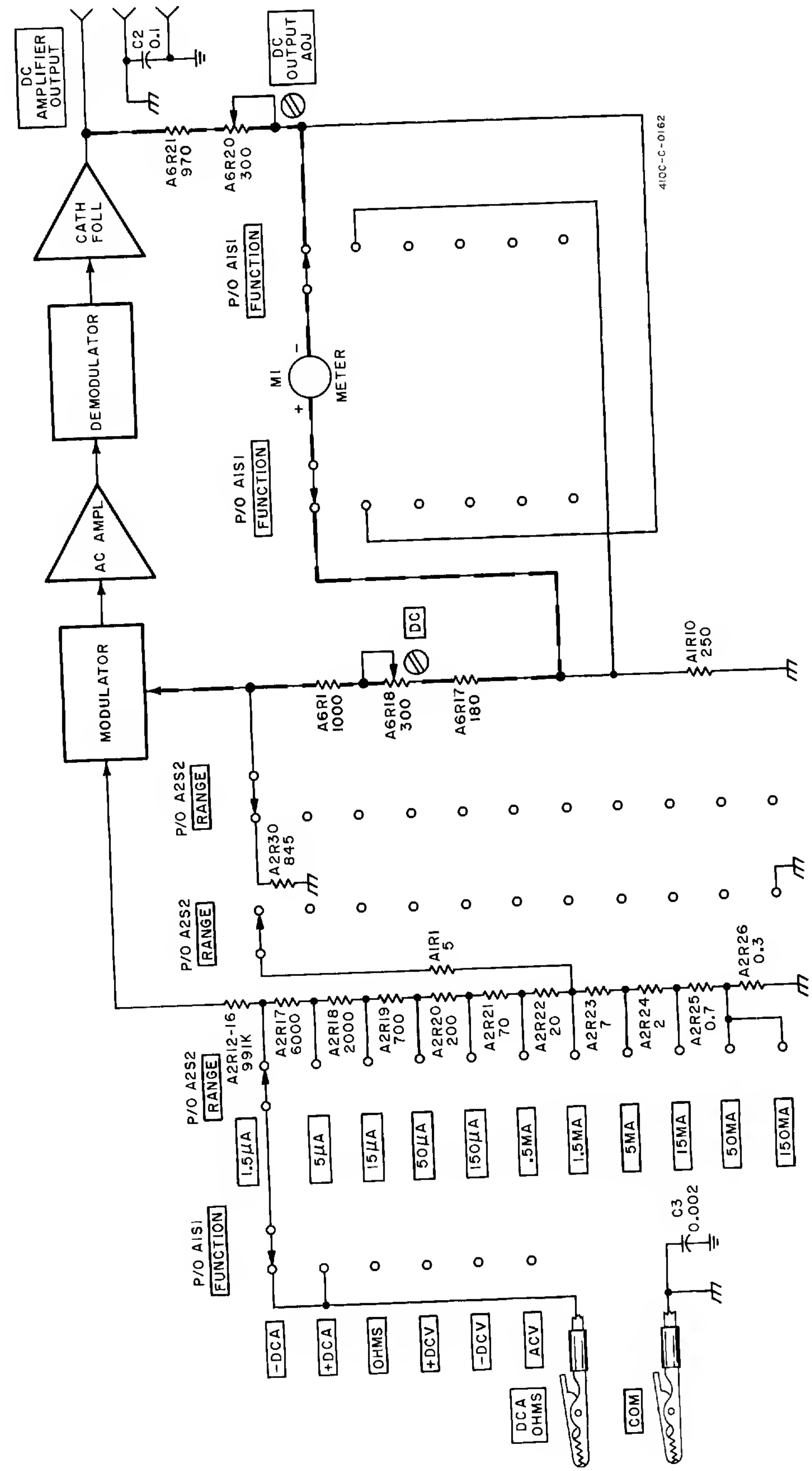

Figure 4-3. Simplified Schematic, DC Current Measurement

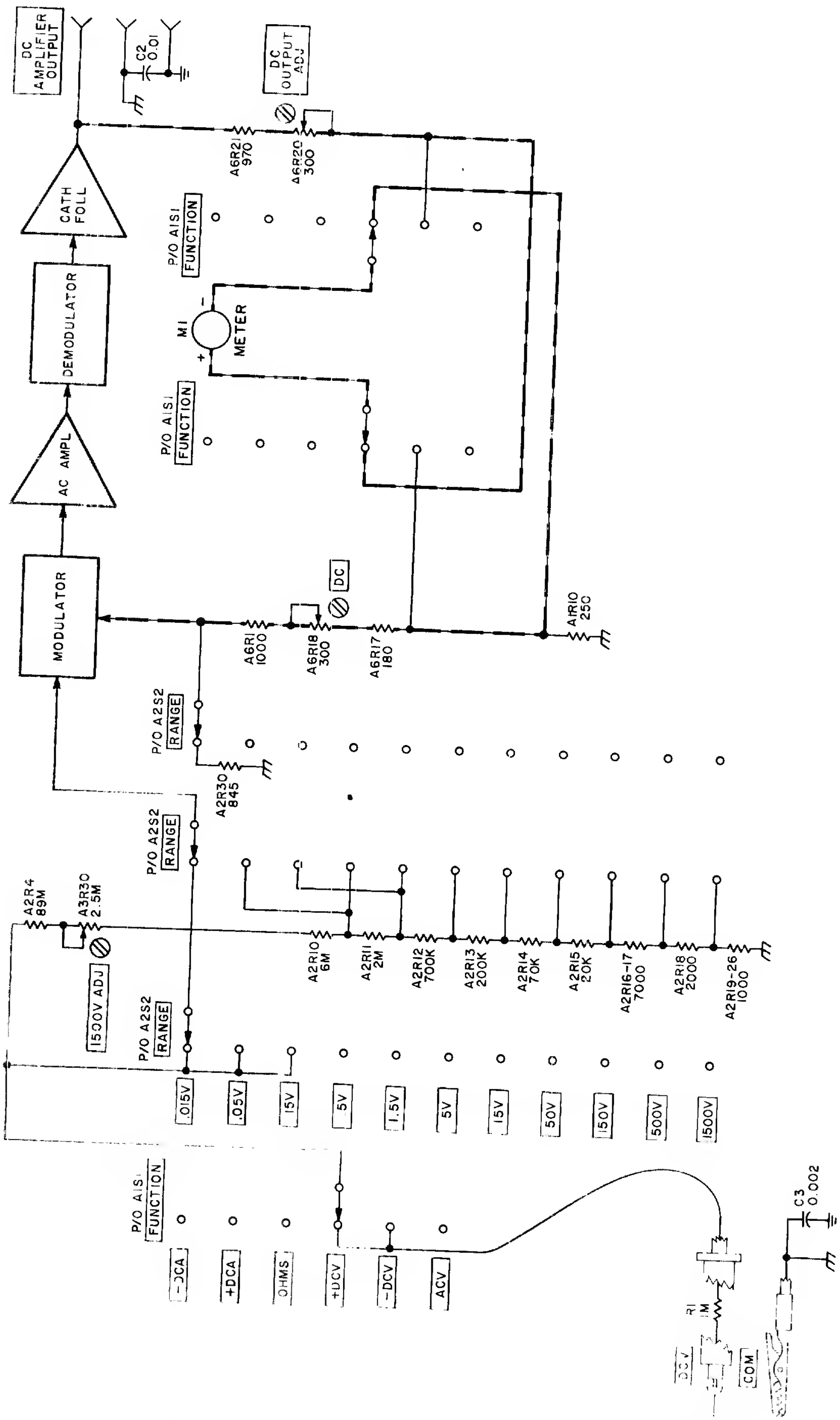

Figure 4-4. Simplified Schematic, DC Voltage Measurements

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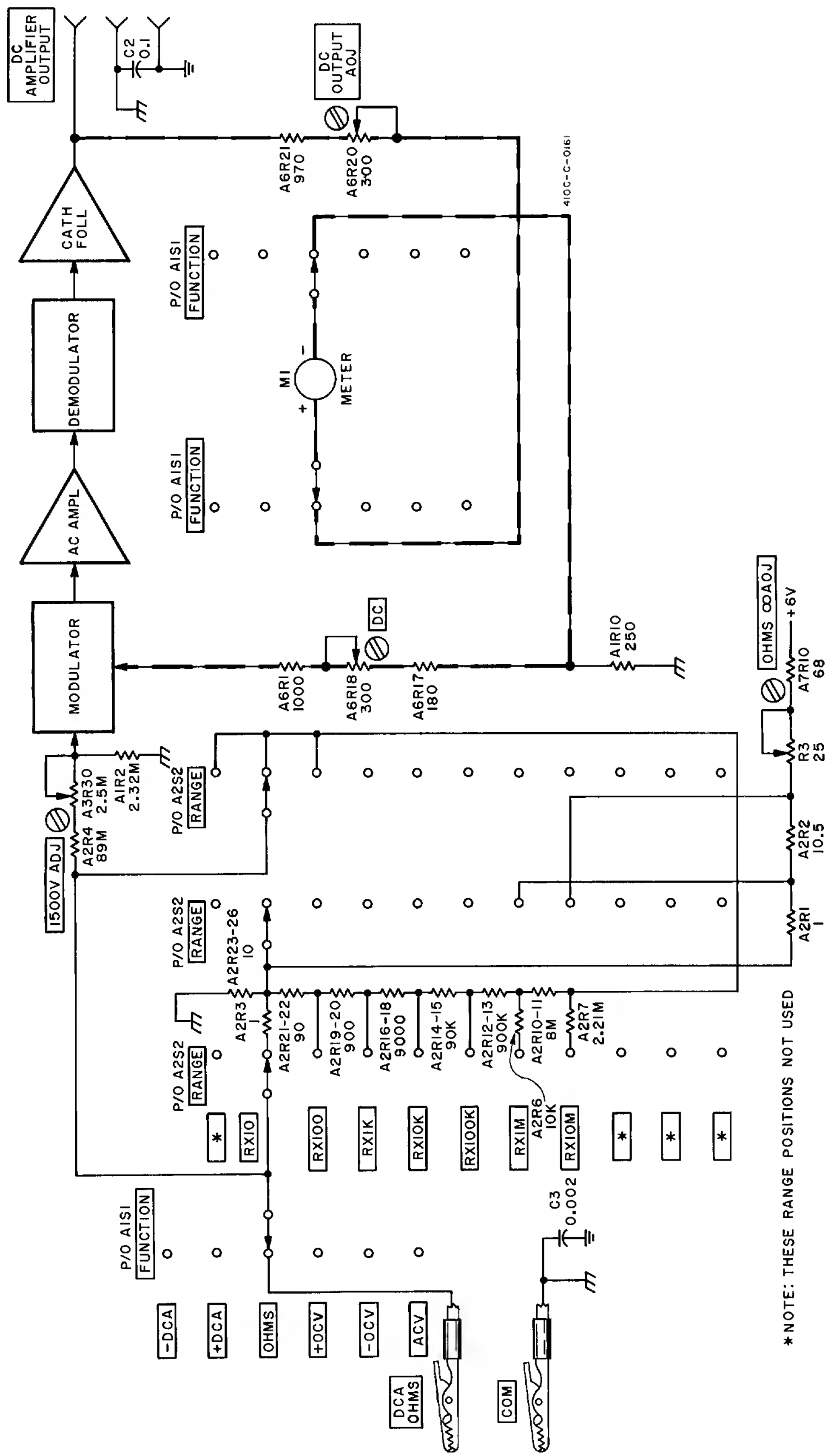

Figure 4-5. Simplified Schematic, Resistance Measurement

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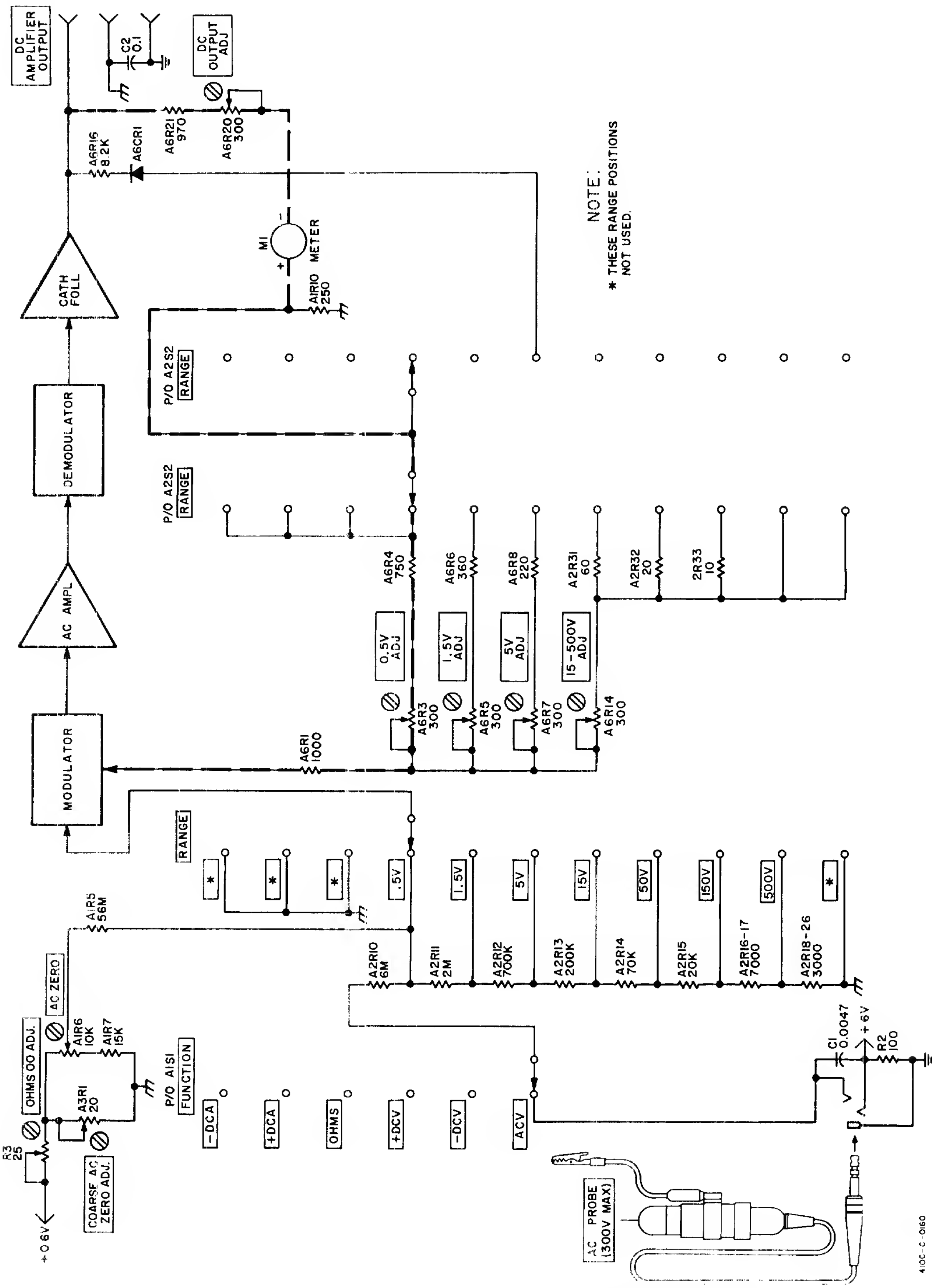

Figure 4-6. Simplified Schematic, AC Voltage Measurement

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NOTES

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Table 5-1. Recommended Test Equipment

Instrument Type	Required Characteristics	Use	Recommended Model
Voltmeter Calibrator	Range: .015 to 300 v Frequency: DC and 400 cps Accuracy: ±0.3% AC ±0.2% DC	AC and DC Accuracy Checks and Calibration Adjustments	ⓗⓟ Model 738BR Voltmeter Calibrator
DC Power Supply	Range: 0 to 10 v continuous	DC Ammeter Accuracy Checks	ⓗⓟ Model 723A DC Power Supply
DC Voltmeter	Range: 10 v Accuracy: ±0.2%	Accuracy Checks; Power Supply Measurements; Troubleshooting	ⓗⓟ Model 3440A/3442A Digital Voltmeter
Frequency Response Test Set	Frequency: 20 cps to 10 Mc with external oscillator Output: 2 v into 50 ohms	Frequency Response Test	ⓗⓟ Model 739AR Frequency Response Test Set
Oscillator	Frequency: 20 cps to 10 Mc Output: 2.0 v	Frequency Response Test	ⓗⓟ Model 651A Test Oscillator
RF Signal Generator	Frequency: 10 Mc to 480 Mc Output: 1.0 v	Frequency Response Test	ⓗⓟ Model 608C RF Signal Generator
Power Meter	Frequency: 10 Mc to 700 Mc Range: 1.0 v	Frequency Response Test	ⓗⓟ Model 431B Power Meter
VHF Signal Generator	Frequency: 480 Mc to 700 Mc	Frequency Response Test	ⓗⓟ Model 612A VHF Signal Generator
AC Voltmeter	Range: 115 V	Power Supply Measurements (ripple)	ⓗⓟ Model 3400A RMS Voltmeter
Electronic Counter	Frequency Range: to at least 102 cps	Chopper Frequency Adjust	ⓗⓟ Model 521C Electronic Counter
DC Standard	Output: 1000 v Accuracy: ±0.2%	DC Adjust	ⓗⓟ Model 740A DC Standard
Ohmmeter	Range: 100 MΩ Accuracy: ±5%	Troubleshooting	ⓗⓟ Model 412A DC VTVM
Thermistor Mount	Frequency: 10 Mc to 700 Mc Impedance: 50 ohm match	Frequency Response Test	ⓗⓟ Model 478A Coaxial Thermistor Mount
Probe-T-Connector	For use with 50 ohm transmission line	Frequency Response Test	ⓗⓟ Model 11042A Probe-T-Connector
10 KC Filter	High pass filter capable of 10 kc rejection	Frequency Response Test	ⓗⓟ Model K02-411A 10 KC Filter
Connector Adapter	Male BNC to male BNC	Frequency Response Test	ⓗⓟ Part No. 1250-0216
Connector Adapter	Type N male to BNC female	Frequency Response Test	ⓗⓟ Part No. 1250-0067
Resistors:			
10 MΩ	Accuracy: ±1%	Performance Checks	ⓗⓟ Part No. 0730-0168
5 MΩ	Accuracy: ±1%	Performance Checks	ⓗⓟ Part No. 0730-0125
4.5 MΩ	Accuracy: ±1%	Performance Checks	ⓗⓟ Part No. 0730-0157
500 K	Accuracy: ±1%	Performance Checks	ⓗⓟ Part No. 0721-0011
56 K	Accuracy: ±1%	Performance Checks	ⓗⓟ Part No. 0730-0053
10 K	Accuracy: ±1%	Performance Checks	ⓗⓟ Part No. 0727-0157
9 K	Accuracy: ±1%	Performance Checks	ⓗⓟ Part No. 0730-0026
1.5 K	Accuracy: ±1%	Performance Checks	ⓗⓟ Part No. 0730-0017
56 ohms	Accuracy: ±1%	Performance Checks	ⓗⓟ Part No. 0811-0341
10 ohms	Accuracy: ±1%	Performance Checks	ⓗⓟ Part No. 0727-0335

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains maintenance procedures for the Model 410C Electronic Voltmeter.

5-3. TEST EQUIPMENT REQUIRED.

5-4. The test equipment required to maintain and adjust the Model 410C is listed in Table 5-1. Equipment having similar characteristics may be substituted for items listed.

5-5. PERFORMANCE CHECKS.

5-6. The performance checks presented in this section are front panel operations designed to compare the Model 410C with it's published specifications. These operations may be incorporated in periodic maintenance, post repair and incoming quality control checks. These operations should be conducted before any attempt is made at instrument calibration or adjustment. During performance checks, periodically vary the line voltage to the Model 410C, ±10% on either 115 v or 230 v operation. A 1/2 hour warm-up period should be allowed before these tests are conducted.

5-7. ALTERNATE VOLTAGE SOURCE.

5-8. Should it be necessary to use the ⓗⓟ Model 738AR Voltmeter Calibrator to conduct these Performance Checks, the arrangement described in Figure 5-1 will provide the necessary voltage values required. However, the ⓗⓟ Model 738BR Voltmeter Calibrator is the preferred instrument for these operations.

5-9. MECHANICAL METER ZERO.

a. Turn instrument on. Allow at least a 20 minute warm-up period.

b. Turn voltmeter off, and allow 30 seconds for all capacitors to discharge.

c. Rotate mechanical zero-adjustment screw on front panel clockwise until pointer reaches zero, moving up scale.

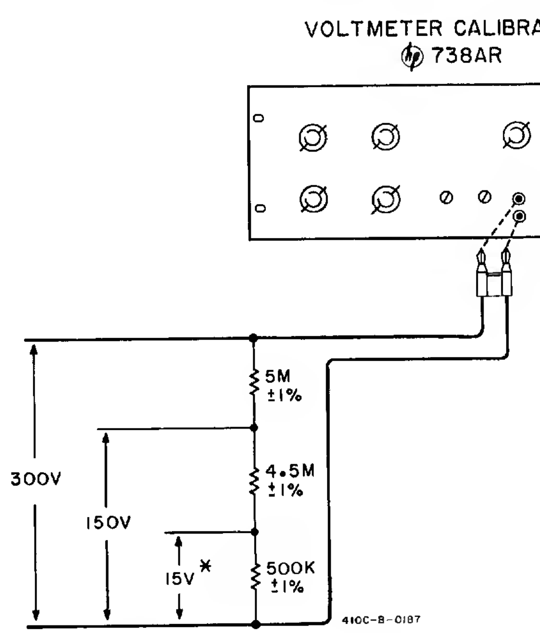
d. If for some reason the pointer should overshoot zero, repeat step c until desired results are obtained.

e. When pointer has been positioned at zero, rotate zero-adjust screw slightly counterclockwise to free it. If meter pointer moves to the left during this action, repeat steps c and e.

5-10. DC VOLTMETER OPERATION.

5-11. ACCURACY CHECK (DCV).

a. Set the Model 410C FUNCTION SELECTOR to the +DCV position; RANGE switch to .015 V. Connect Model 410C DCV and COM cables to the Voltmeter Calibrator (ⓗⓟ Model 738BR) output terminals.



* 1.5V, 150MV AND 15MV CAN BE OBTAINED BY PROPORTIONALLY REDUCING THE 300V SUPPLY.

5M ±1% . . . . ⓗⓟ PART NO. 0730-0125
4.5M ±1% . . ⓗⓟ PART NO. 0730-0157
500K ±1% . . ⓗⓟ PART NO. 0721-0011

Figure 5-1. Alternate Voltage Source

Table 5-2. DCV Accuracy Test

Model 410C Range Settings	Voltmeter Calibrator Model 738B Settings		Model 410C Meter Readings
	Range	Voltage	
.015 V	1.5-5	.015	.0147 to .0153 V
.05 V	1.5-5	.05	.049 to .051 V
.15 V	1.5-5	.15	.147 to .153 V
.5 V	1.5-5	.5	.49 to .51 V
1.5 V	1.5-5	1.5	1.47 to 1.53 V
5 V	1.5-5	5	4.9 to 5.1 V
15 V	1.5-5	15	14.7 to 15.3 V
50 V	1.5-5	50	49 to 51 V
150 V	1.5-5	150	147 to 153 V
500 V	1-3	300	290 to 310 V
1500	1-3	300	270 to 330 V

b. Adjust Voltmeter Calibrator to provide a +.015 v dc voltage.

c. Model 410C should read between 0.0147 and 0.0153 v.

d. Readjust Model 410C and Voltmeter Calibrator to settings listed in Table 5-2. Note Model 410C meter readings. If Model 410C fails to meet specifications, refer to Paragraph 5-35 for proper adjustment procedure.

5-12. INPUT RESISTANCE CHECK (DCV).

a. Connect an external resistor, R_x, of 10 M ohms ±1% (hp Part No. 0370-0168) in series between the voltmeter calibrator and the DCV cable of the Model 410C.

b. Set Model 410C FUNCTION selector to +DCV; RANGE to .015 V.

c. Adjust voltmeter calibrator for +.015v DC output.

d. Model 410C should read .0075 v, verifying R_{in} of 10 M ohms.

e. Table 5-3 provides settings required to verify Model 410C R_{in} on RANGES specified.

Where

$$E_{410C} = \frac{E_{738BR}}{2} \quad \text{when} \quad R_x = R_{410C}$$

$$E_{410C} = \frac{(E_{738BR})(10)}{110} \quad \text{when} \quad R_x = \frac{R_{410C}}{10}$$

5-13. DC AMMETER OPERATION.

5-14. ACCURACY CHECK (DCA).

a. Figure 5-2 describes the test arrangement required for this operation. The following additional equipment will also be required:

DC Power Supply (hp Model 723A)

DC Voltmeter (hp Model 3440A/3442A)

10 K, 1%, 1 w resistor (hp Part No. 0727-0157)

56 K, 1%, 1 w resistor (hp Part No. 0730-0053)

10 Ω, 1%, 1 w resistor (hp Part No. 0727-0335)

56 Ω, 1%, 1/2 w resistor (hp Part No. 0811-0341)

b. Connect the Model 410C as shown in Figure 5-2; FUNCTION SELECTOR to +DCA; RANGE to 150 MA.

c. Use 56 ohm resistor for R1 and 10 ohm resistor for R2.

d. Adjust dc power supply to obtain 1.4 v reading on system voltmeter.

e. Model 410C should read between 135.5 and 144.5 ma.

f. Adjust dc power supply for system voltmeter readings listed in Table 5-4. Note Model 410C meter readings.

5-15. INPUT RESISTANCE CHECK (DCA).

a. Figure 5-2 describes the test arrangement required for this operation. Replace R1 and R2 with a 10 ohm ±1% resistor (hp Part No. 0727-0335).

b. Set Model 410C FUNCTION SELECTOR to +DCA; RANGE to 150 MA.

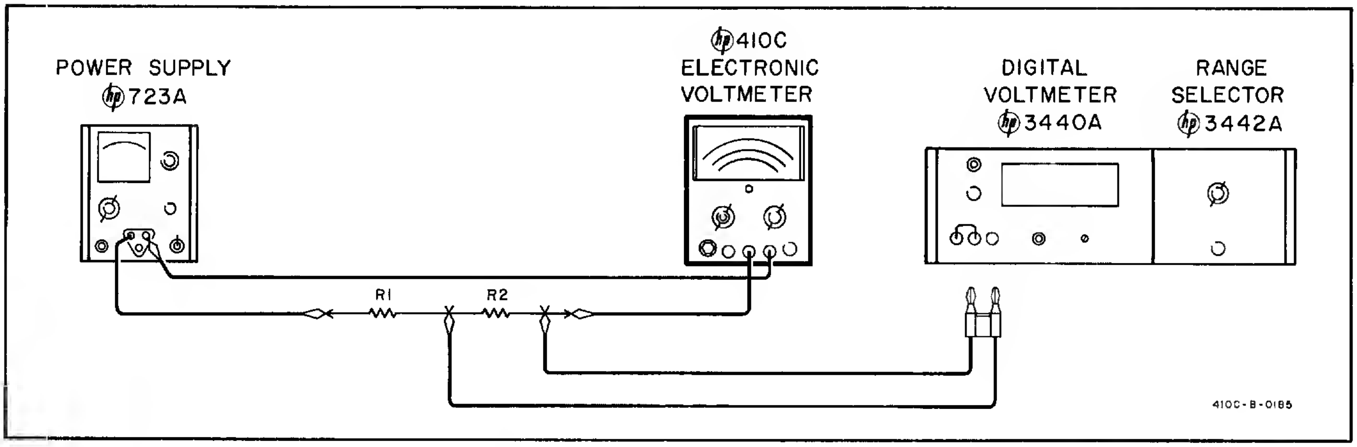


Figure 5-2. DC Ammeter Operation

Table 5-3. DCV Input Resistance Test

$R_x \Omega$, ±1%	Model 410C Range Settings	Voltmeter Calibrator Model 738B		Model 410C Meter Readings	Model 410C R_{in}
		Range	Voltage		
10 M	.015 V	1.5-5	.015	.0075 V	10 MΩ ±3%
10 M	.05 V	1.5-5	.05	.025 V	10 MΩ ±3%
10 M	.15 V	1.5-5	.15	.075 V	10 MΩ±3%
10 M	.5 V	1.5-5	.5	.455 V	100 MΩ ±1%
10 M	1.5 V	1.5-5	1.5	1.36 V	100 MΩ ±1%
10 M	5 V	1.5-5	5	4.55 V	100 MΩ ±1%
10 M	15 V	1.5-5	15	13.6 V	100 MΩ ±1%
10 M	50 V	1.5-5	50	45.5 V	100 MΩ ±1%
10 M	150 V	1.5-5	150	136.5 V	100 MΩ ±1%
10 M	500 V	1.5-5	300	272.7 V	100 MΩ ±1%
10 M	1500 V	1.5-5	300	272.7 V	100 MΩ ±1%

Table 5-4. DCA Accuracy Test

Model 410C Range Settings	System Voltmeter Readings Model 3400A	Model 410C Meter Readings	R_1 Ω	R_2 Ω
150 MA	1.4 V	135.5 to 144.5 MA	56	10
50 MA	.4 V	38.5 to 41.5 MA	56	10
15 MA	.14 V	13.55 to 14.55 MA	56	10
5 MA	.04 V	3.85 to 4.15 MA	56	10
1.5 MA	.014 V	1.35 to 1.45 MA	56	10
.5 MA	.004 V	0.385 to 0.415 MA	56	10
150 μa	1.38 V	133.5 to 142.5 μa	56 K	10 K
50 μa	0.46 V	44.5 to 47.5 μa	56 K	10 K
15 μa	0.138 V	13.35 to 14.25 μa	56 K	10 K
5 μa	0.046 V	4.45 to 4.75 μa	56 K	10 K
1.5 μa	0.014 V	1.36 to 1.45 μa	56 K	10 K

c. Adjust dc power supply to provide system voltmeter reading of 1.50 v.

e. Model 410C should read approximately 150 ma. This will verify a R_{in} of approximately 0.3 ohms, where

$$R_{410C} = \frac{E_{total} - R_x I_{410C}}{I_{410C}}$$

f. Set Model 410C RANGE to 1.5 µa.

g. Replace R_x with a 9 K ohm ±1% resistor (hp Part No. 0730-0026).

h. Adjust dc power supply to provide system voltmeter reading of 13.5 mv.

j. Model 410C should read approximately 1.5 µa. This will verify R_{in} of 9 K on 1.5 µa range.

5-16. OHMMETER OPERATION.

a. A 10 ohm ±1% resistor (hp Part No. 0727-0335) and a 10 M resistor (hp Part No. 0730-0168) will be required for this test.

b. Set Model 410C FUNCTION SELECTOR to OHMS; RANGE to RX10.

c. Set pointer to ∞ using rear panel adjustment (OHMS ADJ) if required.

d. Connect COM and DCA OHMS cables across 10 ohm resistor.

e. Meter should read 1 (±5%), indicating 10 ohms.

f. Reset Model 410C RANGE to RX10M. Replace 10 ohm resistor with 10 M ohm resistor.

g. Meter should read 1 (±5%), indicating 10 M ohms.

h. If both of these ranges function properly, it can be assumed that the remainder will also. If meter does not function properly, refer to Paragraph 5-31 for adjustment procedure.

5-17. AMPLIFIER OPERATION.

5-18. AMPLIFIER ACCURACY CHECK.

a. A Voltmeter Calibrator (hp Model 738BR) and a DC Voltmeter (hp Model 3440A/3442A) will be required for this operation.

b. Connect dc voltmeter to dc amplifier OUTPUT on Model 410C rear panel. Place ground lead between Model 410C circuit and earth ground terminals. Set dc voltmeter RANGE to 10 V.

c. Set Model 410C RANGE to 500 V; FUNCTION SELECTOR to ACV.

d. Adjust voltmeter calibrator to provide a 300 V reading on the Model 410C meter.

e. DC Voltmeter should read 0.9 V.

f. Continue test using voltmeter calibrator settings listed in Table 5-5. Note and compare Model 410C and dc voltmeter readings with those listed in Table 5-5.

g. If readings do not correspond with those listed in Table 5-5, refer to Paragraph 5-34 for proper adjustment procedure.

5-19. AMPLIFIER GAIN CHECK.

a. Connect Voltmeter Calibrator (hp Model 738BR) output to Model 410C DCV and COM cables.

b. Connect DC Voltmeter (hp Model 3440A/3442A) to DC AMPLIFIER OUTPUT on rear panel of Model 410C. Set DC Voltmeter RANGE to 10 V.

Table 5-5. DC Voltage Output Test

Voltmeter Calibrator Settings		Model 410C Range Settings	Model 410C Meter Readings	DC Voltmeter Readings
Range	Voltage			
1-3	300	500 V	300 V	0.9 V
1.5-5	150	150 V	150 V	1.5 V
1.5-5	50	50 V	50 V	1.5 V
1.5-5	15	15 V	15 V	1.5 V
1.5-5	5	5 V	5 V	1.5 V
1.5-5	1.5	1.5 V	1.5 V	1.5 V
1.5-5	.5	.5 V	.5 V	1.5 V

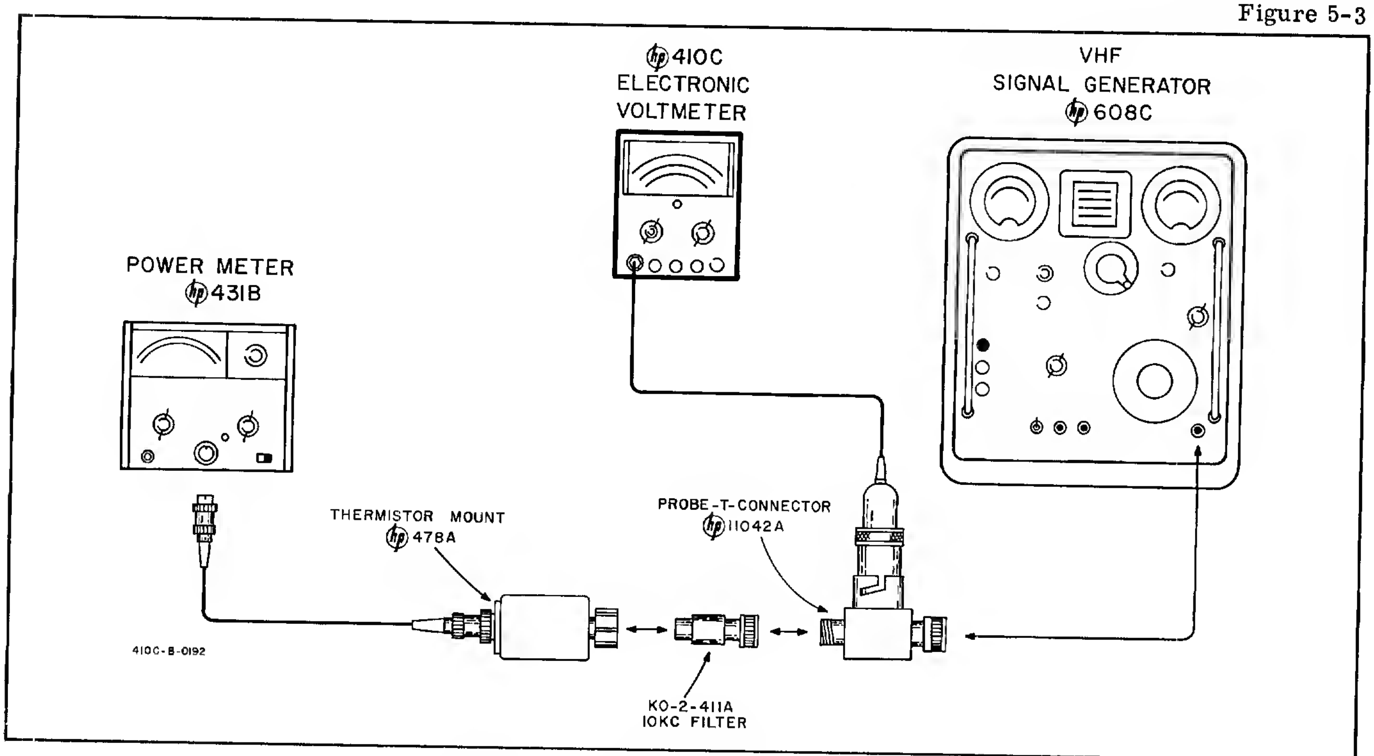


Figure 5-3. High Frequency Response Test

c. Set Model 410C FUNCTION SELECTOR to +DCV ; RANGE to .015 V.

d. Adjust voltmeter calibrator for +.015 VDC output.

e. The dc voltmeter should read +1.5 v. This will verify a gain of 100, when the gain /A/ equals $E_{DC\ out}/E_{410C}$.

5-20. AMPLIFIER NOISE CHECK.

a. Leave the dc voltmeter connected to the DC AMPLIFIER OUTPUT as in Paragraph 5-19.

b. Set the Model 410C RANGE to 1500 V; FUNCTION SELECTOR to +DCV.

c. Short the Model 410C DCV and COM cables. Note dc voltmeter readings. This reading should be less than 7.5 v.

d. Reset Model 410C RANGE to 1.5 V. DC Voltmeter should read less than 7.5 mv.

5-21. DC AMPLIFIER OUTPUT IMPEDANCE CHECK.

a. Connect an external DC Voltmeter (hp Model 3440A/3442A) to Model 410C DC AMPLIFIER OUTPUT terminals on rear panel.

b. Set Model 410C FUNCTION SELECTOR to OHMS position.

c. Record voltage indicated on external dc voltmeter for use as a reference.

d. Connect a 1.5 k ohm ±1% resistor (hp Part No. 0730-0017) across Model 410C DC AMPLIFIER OUTPUT terminals. DC voltage recorded in step c above should not change more than 3 mv, indicating that dc amplifier output impedance is within the 3 ohm specification at dc.

5-22. AC VOLTMETER OPERATION.

5-23. 11036A AC PROBE ACCURACY CHECK.

a. Figure 5-3 describes the test arrangement required for this operation. Do not place Model 410C AC Probe in T-Connector at this point.

b. Adjust signal generator for a 0.7 volt (rms) output at 1000 cps.

c. Connect Model 11036A AC Probe to signal generator and read output on Model 410C Voltmeter (meter should read 0.7 volts).

d. Remove probe tip from Model 11036A and connect the ac probe as shown in Figure 5-4.

e. Turn signal generator to 50 Mc and adjust signal generator for a power reading of 9.8 dbm (0.7 volts) on the power meter.

f. The difference between reading on Model 410C meter and 0.7 volt reference is the ac probe error at that frequency.

g. Repeat steps f and g every 100 Mc from 50 to 700 Mc.

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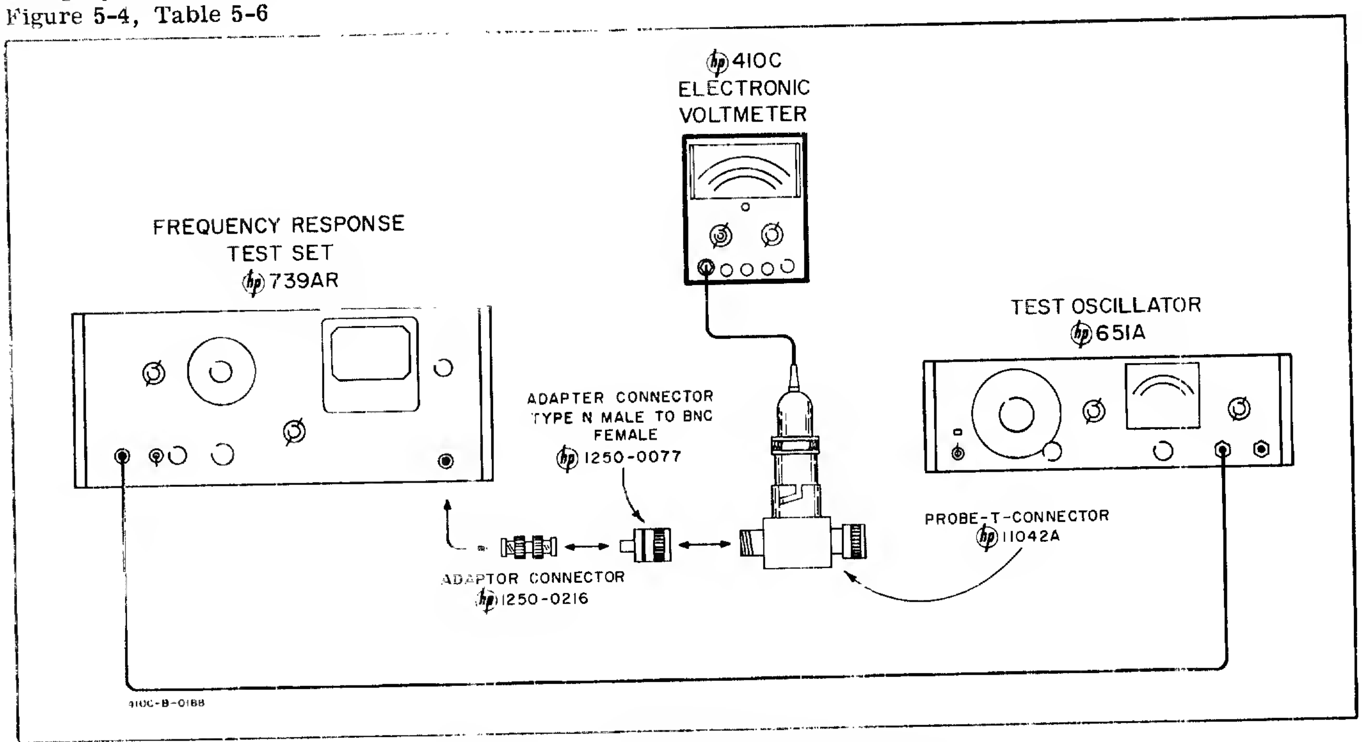

Figure 5-4. Low Frequency Response Test

5-24. AC VOLTMETER ACCURACY CHECK.

a. A Voltmeter Calibrator (hp Model 738BR) will be required for this operation.

b. Adjust voltmeter calibrator for 400 cps-rms output.

c. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to 500 V.

d. Adjust the voltmeter calibrator to settings listed in Table 5-6. Model 410C should indicate readings within limits specified. If not, refer to Paragraph 5-33 for corrective action.

5-25. AC VOLTMETER FREQUENCY RESPONSE CHECK.

a. A Frequency Response Test Set (hp Model 739AR), a Test Oscillator (hp Model 651A), an RF Signal Generator (hp Model 608C), a Power Meter (hp Model 431B), a Thermistor Mount (hp Model 478A), a Probe-T-Connector (hp Model 11042A), a VHF Signal Generator (hp Model 612A) and a 10 KC Filter (hp Model K02-411A) will be required for this operation. Figure 5-3 and 5-4 describe the arrangement to be used.

Table 5-6. AC Accuracy Test

Model 410C Range	Voltmeter Calibrator 400 cps		Model 410C Readings
	Range	Voltage Selector	
500 V	1-3	300	285 to 315 V
150 V	1.5-5	150	142.5 to 157.5 V
50 V	1.5-5	50	47.5 to 52.5 V
15 V	1.5-5	15	14.25 to 15.75 V
5 V	1.5-5	5	4.75 to 2.25 V
1.5 V	1.5-5	1.5	1.425 to 1.575 V
.5 V	1.5-5	.5	.475 to .525 V
.15 V	1.5-5	.15	.1425 to .1575 V
.05 V	1.5-5	.05	.0475 to .0525 V
.015 V	1.5-5	.015	.0148 to .0158 V

b. Connect the Model 410C as shown in Figure 5-4. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to 1.5 V.

c. Set frequency response test set to EXTERNAL.

d. Adjust test oscillator output AMPLITUDE to provide Model 410C reading of 1.4 V; FREQUENCY to 400 cps.

e. Set frequency response test set METER SET to convenient SET LEVEL.

f. Vary test oscillator frequency from 20 cps to 10 Mc. Model 410C should read between 1.25 and 1.55 v at all frequencies.

g. If frequency response test set deflection varies from preset SET LEVEL, adjust test oscillator output amplitude to return pointer to original position.

h. To check Model 410C frequency response from 10 Mc to 480 Mc, use arrangement described in Figure 5-3.

j. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to .5 V.

k. Adjust RF signal generator to provide Model 410C reading of 0.45 V at 10 Mc. Note power meter reading; mark for future reference.

m. Vary RF signal generator frequency from 10 Mc to 480 Mc. Model 410C should read between 0.40 to 0.50 v at all frequencies.

n. If power meter pointer varies from reference determined in step k above, readjust RF signal generator OUTPUT LEVEL to return pointer to reference deflection.

p. To check Model 410C frequency response from 480 Mc to 700 Mc, replace RF signal generator with VHF Signal Generator (hp Model 612A) and repeat steps j through p above. Model 410C should not vary more than ±10% from reference.

5-26. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-27. The following is a complete adjustment and calibration procedure for the Model 410C. These operations should be conducted only if it has previously been established by Performance Checks, Paragraph 5-5, that the Model 410C is out of adjustment. Indisriminate adjustment of the internal controls to "refine" settings may actually cause more difficulty. If the procedures outlined do not rectify any discrepancy that may exist, and all connections and settings have been rechecked, refer to Paragraph 5-36, Troubleshooting, for possible cause and recommended corrective action.

5-28. CHOPPER FREQUENCY ADJUST.

a. A Voltmeter Calibrator (hp Model 738BR) and an Electronic Counter (hp Model 521C) and an AC Voltmeter (hp Model 3400A) will be required.

b. Use ac voltmeter to verify Model 410C line voltage of 115 v. Chopper frequency will vary with line voltage variations.

c. Set Model 410C FUNCTION SELECTOR to +DCV; RANGE to 1.5 V.

d. Adjust voltmeter calibrator to supply +5 V dc to the Model 410C (DCV and COM cables).

e. Observe counter , and adjust A3R5 for a chopper frequency of 100 cps (±2 cps).

5-29. POWER SUPPLY ADJUSTMENT.

a. Refer to Table 5-7 for Power Supply check points and typical voltage values. Measure dc voltages between common and designated location on A7.

b. Set Model 410C FUNCTION to ACV. Short ACV and COM cable.

Table 5-7. Power Supply Test

Voltage	Location on A7	Tolerance
+175 V	Wht/blk and Orange	±30 V
+38 V	Junction of CR6 and R4	±8.0 V
+6 V	Cathode of CR8	±0.6 V
-9.1 V	Anode of CR7	±1.8 V

c. Measure +175 volt ac ripple with ac voltmeter (hp Model 3400A). RMS value of ripple should not exceed 2.5 mv.

5-30. DC ZERO ADJUSTMENT (BIAS).

a. Set Model 410C FUNCTION SELECTOR to +DCV; RANGE to 1500 V.

b. Short Model 410C DCV cable to COM cable.

c. Adjust A3R21 for zero meter deflection. Check zero setting at each RANGE from 1500 to .015 v. Zero offset should not exceed 1% on any range.

5-31. OHMS ADJUST (R3).

a. Set Model 410C FUNCTION SELECTOR to OHMS; RANGE to RX10M.

b. Short OHMS and COM cables. Model 410C should read zero.

c. Vary Model 410C RANGE switch through remainder of OHMS settings. Meter should read zero, except at RX10 when meter should read about 0.1 ohms (resistance of leads).

d. Disconnect OHMS and COM cables. Model 410C meter should read ∞. If not, set OHMS ADJ (rear panel) for ∞ reading. Check ∞ reading on all OHMS RANGE settings.

5-32. AC ZERO ADJUST.

a. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to .5 V.

b. Set AC ZERO vernier on front panel to center of rotation.

c. Short Model 410C ac probe and ac probe common (short lead).

d. Adjust A3R1 for Model 410C zero deflection.

5-33. AC FULL SCALE ADJUST (.5 V RANGE).

a. Connect Model 410C ac probe to voltmeter calibrator output terminals. Set Model 410C FUNCTION SELECTOR to ACV; RANGE to 500 V.

b. Adjust voltmeter calibrator to provide 300 v, 400 cps - rms output. Model 410C should read 300 v (±3%). If not, adjust A6R3 for proper reading.

c. Continue test for remainder of Model 410C ac ranges using settings provided in Table 5-8.

5-34. DC AMPLIFIER OUTPUT ADJUST.

a. Set the Model 410C FUNCTION SELECTOR to ACV; RANGE to 5 V.

b. Connect a DC Voltmeter (hp Model 3440A/3442A) to the dc amplifier OUTPUT on the Model 410C rear panel. Set dc voltmeter RANGE to 10 V.

c. Connect Model 410C AC Probe to voltmeter calibrator output. Adjust voltmeter calibrator to provide a 5 v, 400 cps signal.

d. Model 410C should read full scale (5 v). The dc voltmeter should indicate 1.5 V. If it does not, adjust A6R20 for 1.5 v reading.

5-35. FULL SCALE DC ADJUSTMENT.

a. Set Model 410C FUNCTION SELECTOR to +DCV; RANGE to .015 V.

b. Adjust DC Standard (hp Model 740A) to apply .015 to Model 410C.

c. Model 410C should read full scale. If not, adjust A6R18 for proper pointer deflection.

d. Reset Model 410C RANGE to 1500 v. Adjust dc standard for 1000 v output.

e. Adjust A3R30 for Model 410C reading of 985 v (1% low).

f. If an error greater than ±2% of full scale exists on any range between 0.5 v and 1500 v inclusive, select new setting for A3R30 to yield best results over these ranges. If error greater than ±2% of full scale still exists on any of the above ranges, readjust A6R18 to reduce error.

g. If error greater than ±2% of full scale exists on any range between 15 mv and 150 mv inclusive, select new setting for A6R18 to yield best results on these ranges. If error greater than ±2% of full scale still exists on any of the above ranges, readjust A3R30 to reduce error.

h. If error greater than ±2% of full scale exists on both 15 mv to 150 mv and 0.5 v to 1500 v ranges, start by readjusting A6R18 to correct 15 mv and 150 mv range. Once they are within specification, proceed to readjust A3R30 to correct 0.5 v to 1500 v range error.

5-36. TROUBLESHOOTING PROCEDURE.

5-37. This section contains procedures designed to assist in the isolation of malfunctions. These procedures are based on a systematic analysis of the

Table 5-8. AC Full Scale Adjust

Model 410C Range	Voltmeter Calibrator Model 738B Range	Voltmeter Calibrator Model 738B Voltage	Model 410C Reading ±3%	Adjustment
.5 V	1.5-5	.50	.50	A6R3
1.5 V	1.5-5	1.5	1.5	A6R5
5 V	1.5-5	5	5	A6R7
* 15 V	1.5-5	15	15	A6R14
* 50 V	1.5-5	50	50	A6R14
* 150 V	1.5-5	150	150	A6R14
* 500 V	1-3	300	300	A6R14

*A6R14 is proper adjustment of Model 410C for RANGE settings from 15 vac to 500 vac. Select proper A6R14 setting which will provide best overall results for these ranges.

instrument circuitry in an effort to localize the problem. These operations should be undertaken only after it has been established that the difficulty can not be eliminated by the Adjustment and Calibration Procedures, Paragraph 5-26. An investigation should also be made to insure that the trouble is not a result of conditions external to the Model 410C.

5-38. Conduct a visual check of the Model 410C for possible burned or loose components, loose connections, or any other obvious conditions which might suggest a source of trouble.

5-39. Table 5-9 contains a summary of the front-panel symptoms that may be encountered. It should be used in initial efforts to select a starting point for troubleshooting operations.

5-40. Table 5-10, in conjunction with Figure 5-5, contains procedures which may be used as a guide in isolating malfunctions. The steps in Table 5-10 describe the normal conditions which should be encountered during the checks (circled numbers (N)) in Figure 5-5.

5-41. The checks outlined in Table 5-10 are not designed to measure all circuit parameters, rather only to localize the malfunction. Therefore, it is quite possible that additional measurements will be required to completely isolate the problem. Amplifier gain may also vary slightly between instruments; therefore it should not be necessary to precisely duplicate waveforms or values described.

5-42. Voltage values indicated in Table 5-10 are based on .5 vdc input, with Model 410C RANGE switch set to .015 v.

5-43. When required, check power supply voltages as outlined in Paragraph 5-29.

5-44. Refer to Figure 5-9 for typical waveforms encountered in the Model 410C. Waveforms represent signals which occur when instrument is operating during overdriven conditions (.5 vdc input to .015 v RANGE).

5-45. <u>SERVICING ETCHED CIRCUIT BOARDS.</u>

5-46. The ⓗ Model 410C has three etched circuit

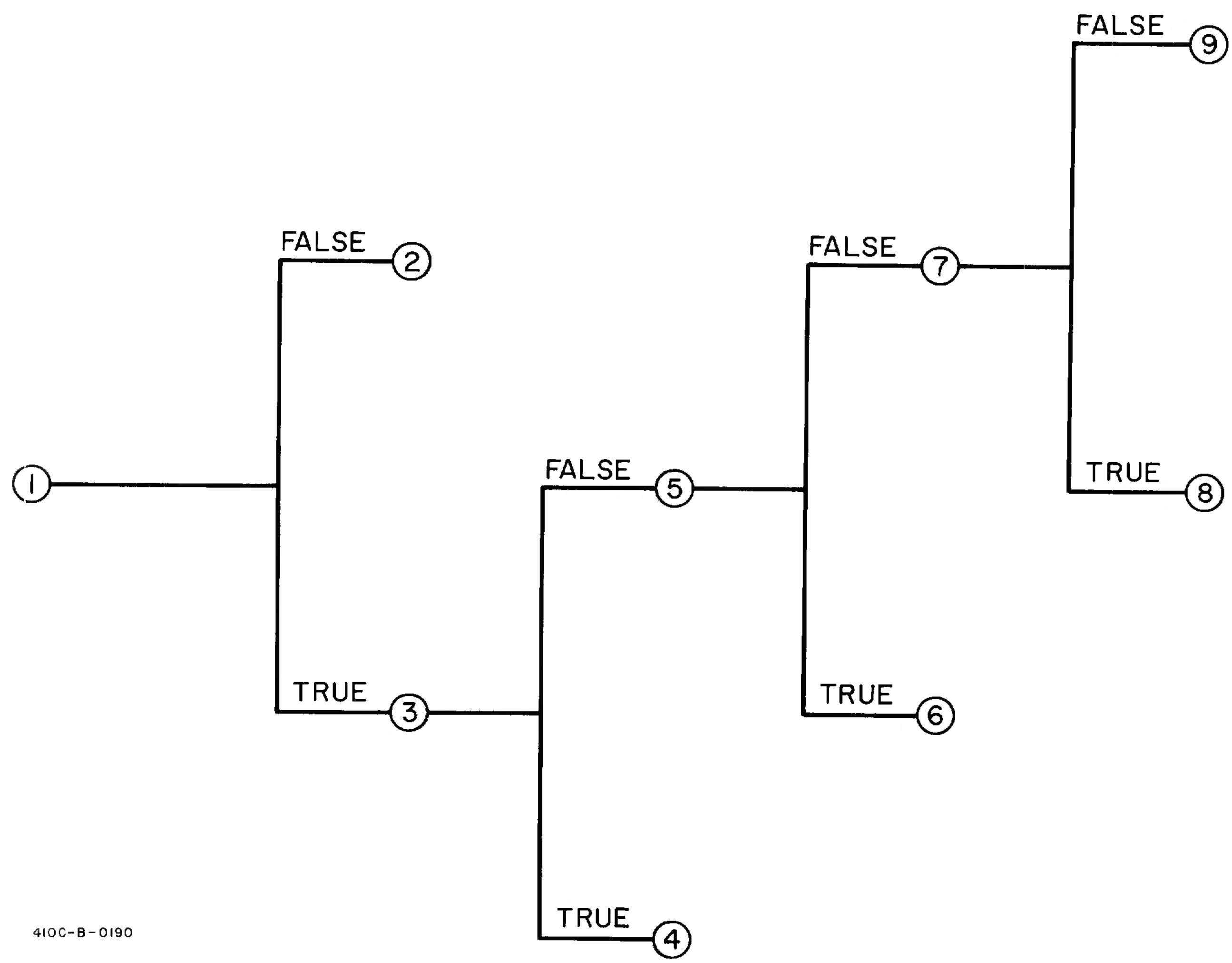

Figure 5-5. Troubleshooting Tree

boards. Use caution when removing them to avoid damaging mounted components. The hp Part Number for the assembly is silk screened on the interior of the circuit board to identify it. Refer to Section VI for parts replacement and hp Part Number information.

5-47. The etched circuit boards are a plated-through type. The electrical connection between sides of the board is made by a layer of metal plated through the component holes. When working on these boards, observe the following general rules.

a. Use a low-heat (25 to 50 watts) small-tip soldering iron, and a small diameter rosin core solder.

b. Circuit components can be removed by placing the soldering iron on the component lead on either side of the board. and pulling up on lead. If a component is obviously damaged, clip leads as close to component as possible and then remove. Excess heat can cause the circuit and board to separate, or cause damage to the component.

c. Component lead hole should be cleaned before inserting new lead.

d. To replace components, shape new leads and insert them in holes. Reheat with iron and add solder as required to insure a good electrical connection.

e. Clean excess flux from the connection and adjoining area.

f. To avoid surface contamination of the printed circuit, clean with weak solution of warm water and mild detergent after repair. Rinse thoroughly with clean water. When completely dry, spray lightly with Krylon (#1302 or equivalent).

5-48. CHOPPER ASSEMBLY INSTALLATION.

a. Figure 5-6 describes the physical orientation of chopper assembly on printed circuit board. Note location of chopper assembly serial number in relation to circuit board pins.

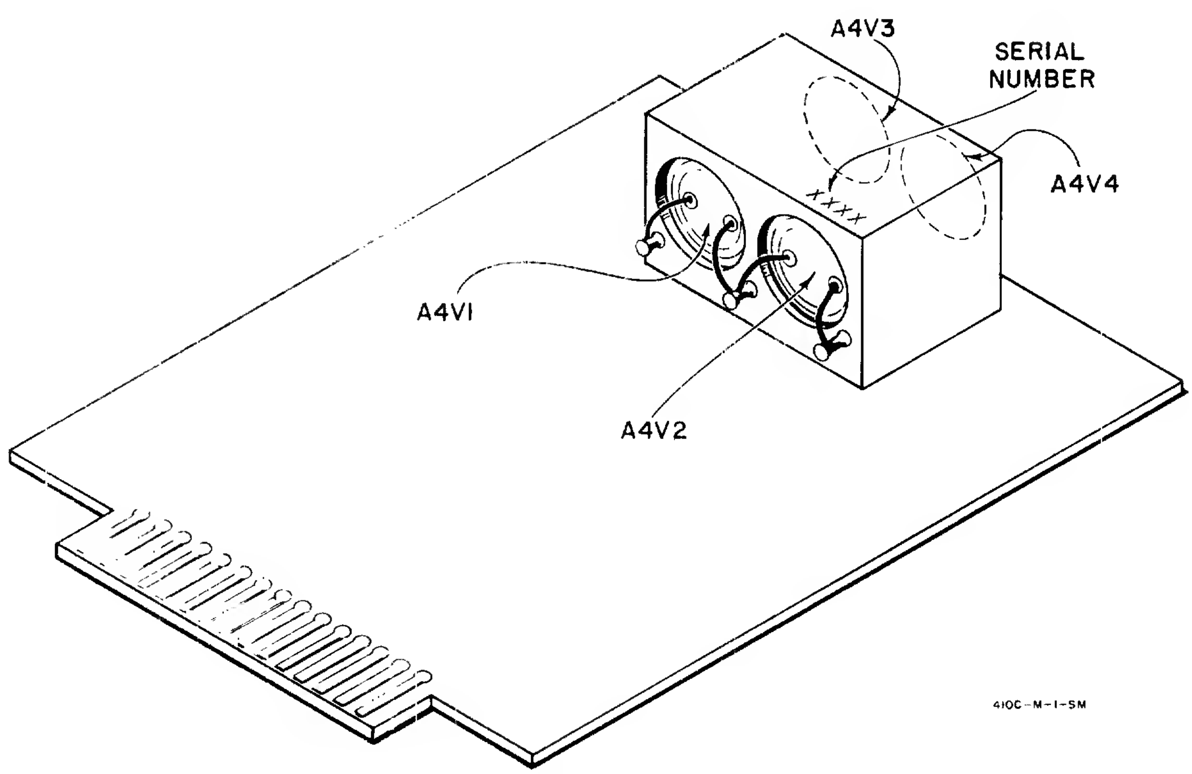

Figure 5-6. Chopper Assembly Installation

Table 5-9. Front Panel Troubleshooting Procedure

FRONT PANEL SYMPTOM	POSSIBLE CAUSE
No meter deflection with input. ON - OFF lamp not glowing.	Check fuse (F1)
In -DCV, pointer deflects 1/2 scale. In +DCV pointer pegs down scale.	Check A3C5
In +DCV pointer pegs down scale. In -DCV pointer pegs up scale.	Check A3Q1, A3C6 or A3C12
Excessive jitter. 0.5 v range or above can not be properly adjusted.	Check A2R2
DC offset in excess of 1%.	Check chopper assembly and A3V1
*DCA mode out on 50 ma and 150 ma ranges.	Check A2R25 and A2R26
*If ∞ ADJ is effective in ranges from RX10 to RV1M, then shifts when RANGE switch is set to RX10M.	Check A2R2
*AC ZERO will not adjust properly. Pointer responds to input variations.	Check A1R5, A1R6, A1R7 and A3R31
*Operates in DCV mode on ranges .015 v to .15 v, but fails on higher ranges.	Check A2R2 and A3R30
DC amplifier outpu is +1.5 v. Meter will not deflect full scale in DCV or DCA mode.	Check A6R21, A6R20, A6R1, A6R18 and A6R17.
*Meter pegs up scale on all ranges. +DC Amplifier output is high regardless of mode of operation.	Check A1R10
In ACV mode pointer will not deflect full scale with proper input applied.	Refer to Paragraph 5-34
Operates on all ranges in ACV mode except 5 v ac position.	Check A6R16 and A6CR1.
Instrument inoperative in all modes. Meter has slight random drift pattern.	Check chopper assembly. Connect 1 M ohm resistor across A4V1. If photocell were open, meter will now respond to input. Use 100 k resistor to check DC - Modulator.
Meter oscillates full scale at rate of 5 - 10 cps.	Check chopper assembly. Connect 1 M ohm resistor across A4V2. If photocell were open, instrument will now respond to input. Use 100 k resistor to check DC - Modulator.
No ac zero.	Check C1 for short to chassis Check ac probe
No deflection on OHMS; dc ranges operative.	Check OHMS and DCA lead for short to common at alligator clip.
.5 and 1.5 VAC range will not track.	Check peak diode. Subsitute know good ac probe.
5 VAC range will not track.	Check A6CR1

*Refer to 6, Table 5-10.

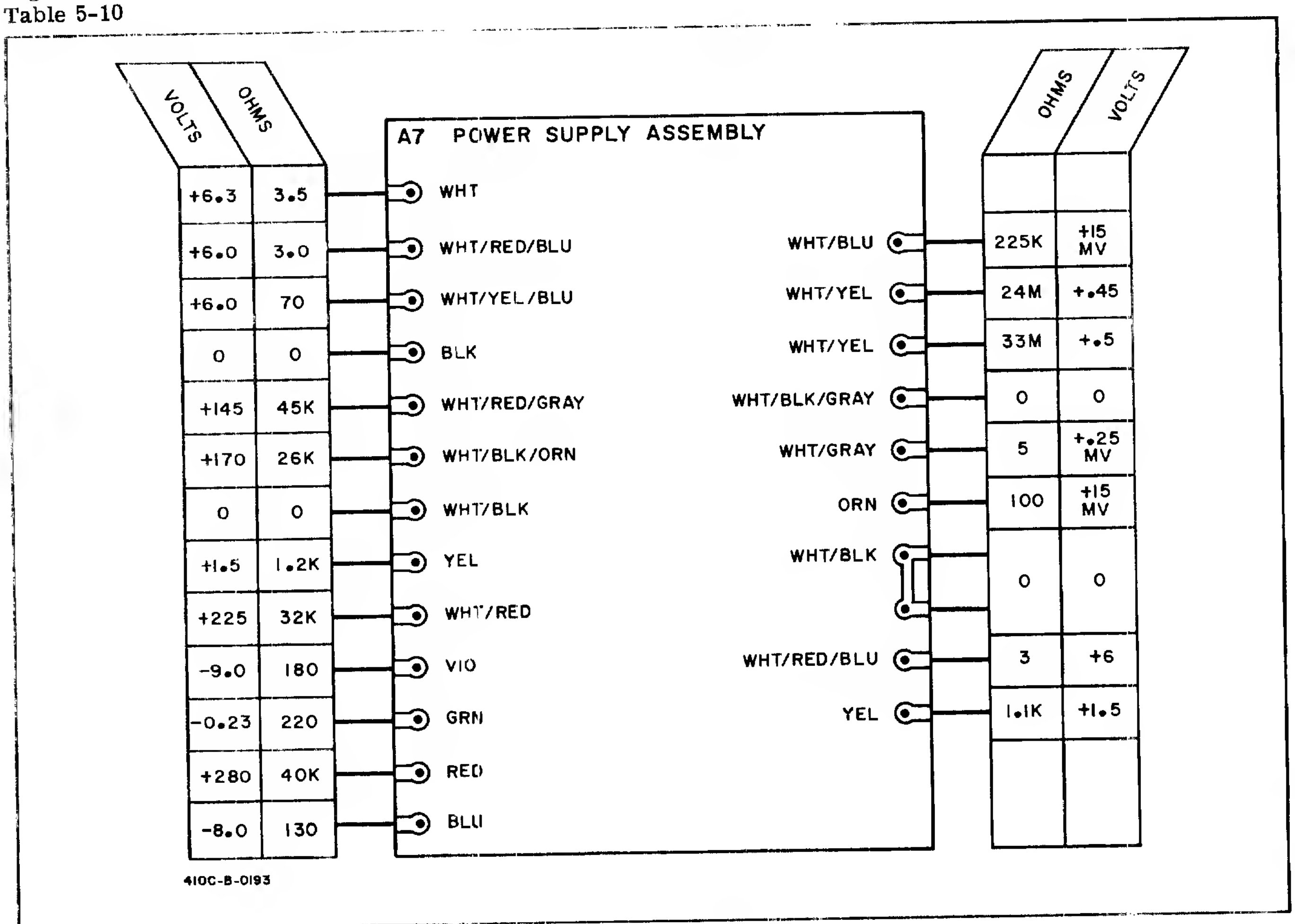

Figure 5-7. Power Supply Measurements

Table 5-10. Troubleshooting Procedure

① Check power supply voltage values using the procedure outlined in Paragraph 5-29. If voltages are correct, proceed to ③ . If voltages are incorrect, proceed to ② .

② If malfunction appears in the power supply, and adjustment of the chopper frequency to 100 cps does not reduce the error, refer to Figure 5-7 for further investigation. Check voltage and resistance values listed. When deviation is noted, trace circuit investigating for faulty component.

③ Measure the dc voltage at the DC AMPLIFIER OUTPUT on Model 410C rear panel. Under overdriven conditions specified, output should be approximately +4.0 v. If this measurement is correct, proceed to ④ ; if not, proceed to ⑤

④ Trace circuit from Pin 11, A3 to Pin 2, A6. Use ohmmeter to check values of A6R21, A6R20, A6R17 and A6R1. Refer to Figure 5-10 for pertinent component and dc voltage values.

⑤ Measure the dc voltage at Pin 1, A3. This voltage is typically 13-15 mv. If this voltage is correct, proceed to ⑥ ; if not, proceed to ⑦ .

⑥ Investigate switch circuit. Refer to astericks in Table 5-9 for hints on how to troubleshoot switch circuit.

⑦ Observe input voltage to demodulator using an oscilloscope. Refer to Figure 5-9 for normal waveform under overdriven conditions specified. If waveform is normal, proceed to ⑧ ; if not, proceed to ⑨ .

⑧ Investigate the demodulator and cathode follower A1V3B. Refer to Figure 5-10 for typical voltage and parameter values. Refer to Table 5-9 for method to check for open demodulator.

⑨ Investigate the modulator and amplifier to include A1V1A, Q1 and Q2. Refer to Figure 5-10 for typical voltage and parameter values. Refer to Table 5-9 for method to check for open modulator.

NOTES

1. ———— — — ———— INDICATES AN ASSEMBLY. ALL COMPONENTS LOCATED ON AN ASSEMBLY ARE PREFIXED BY THE ASSEMBLY DESIGNATION (e.g., R3 ON ASSEMBLY A7 BECOMES A7R3).
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IS IN OHMS.
   CAPACITANCE IS IN MICROFARADS.
3. ⏚ = CABINET GROUND. ⫽ = CIRCUIT GROUND (FLOATING).
4. 980 DENOTES WIRE COLOR USING STANDARD COLOR CODE. (e.g. 9 = WHITE, 8 = GRAY, 0 = BLACK.)
5. ▭ INDICATES FRONT PANEL LOCATION.
   ⬚ INDICATES REAR PANEL LOCATION.

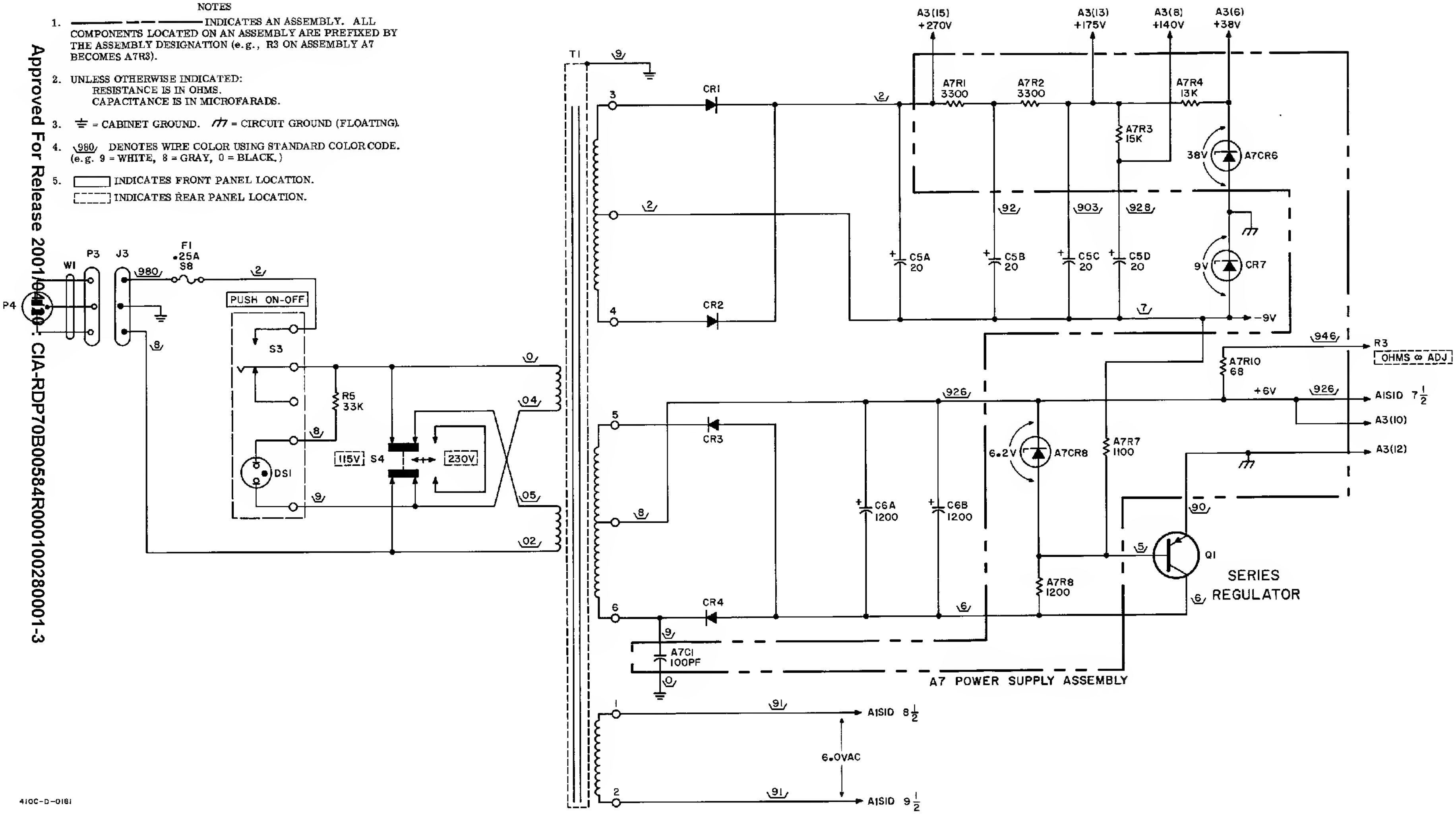

Figure 5-8.

Power Supply Schematic

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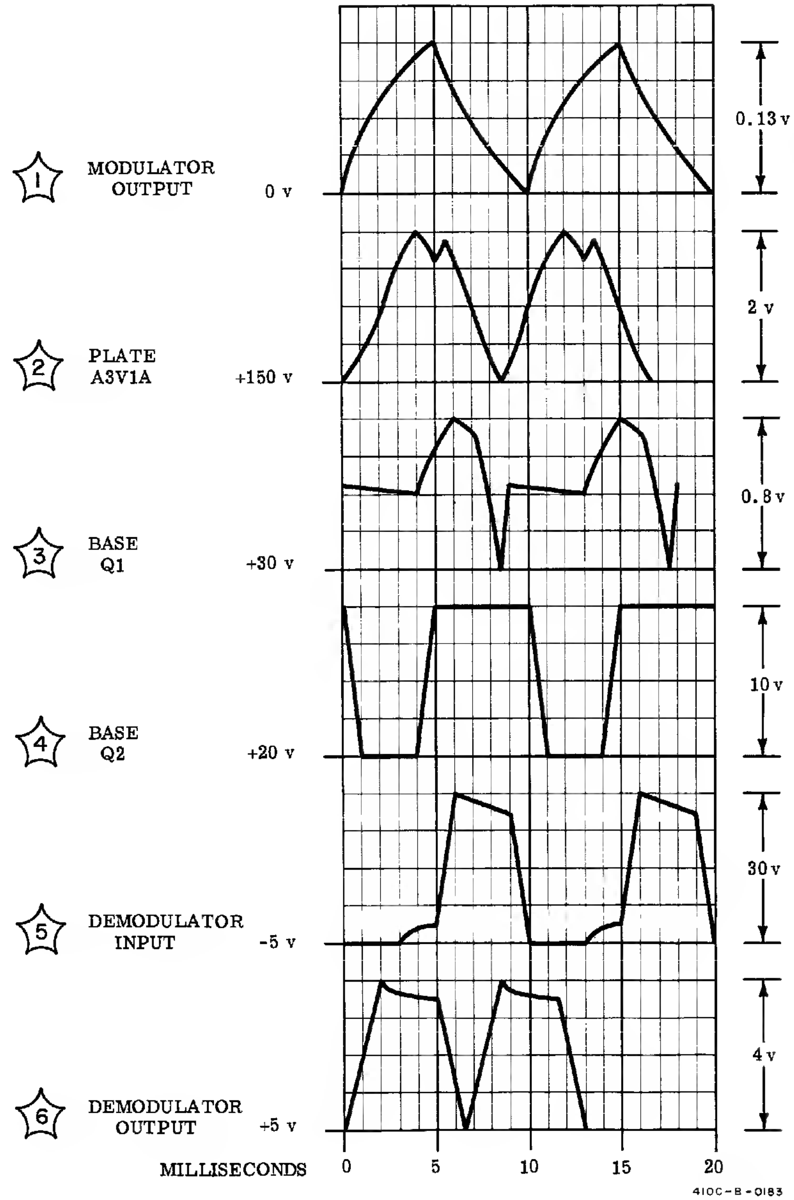

TEST CONDITIONS:
FUNCTION: +DCV
RANGE: .015 V
INPUT: +0.5 V

Waveforms observed on ⓗ Model 175A w/ⓗ Model 1752A and 1780A Plug-ins and 10001A Voltage Divider Probe.

Figure 5-9. Typical Amplifier Waveforms

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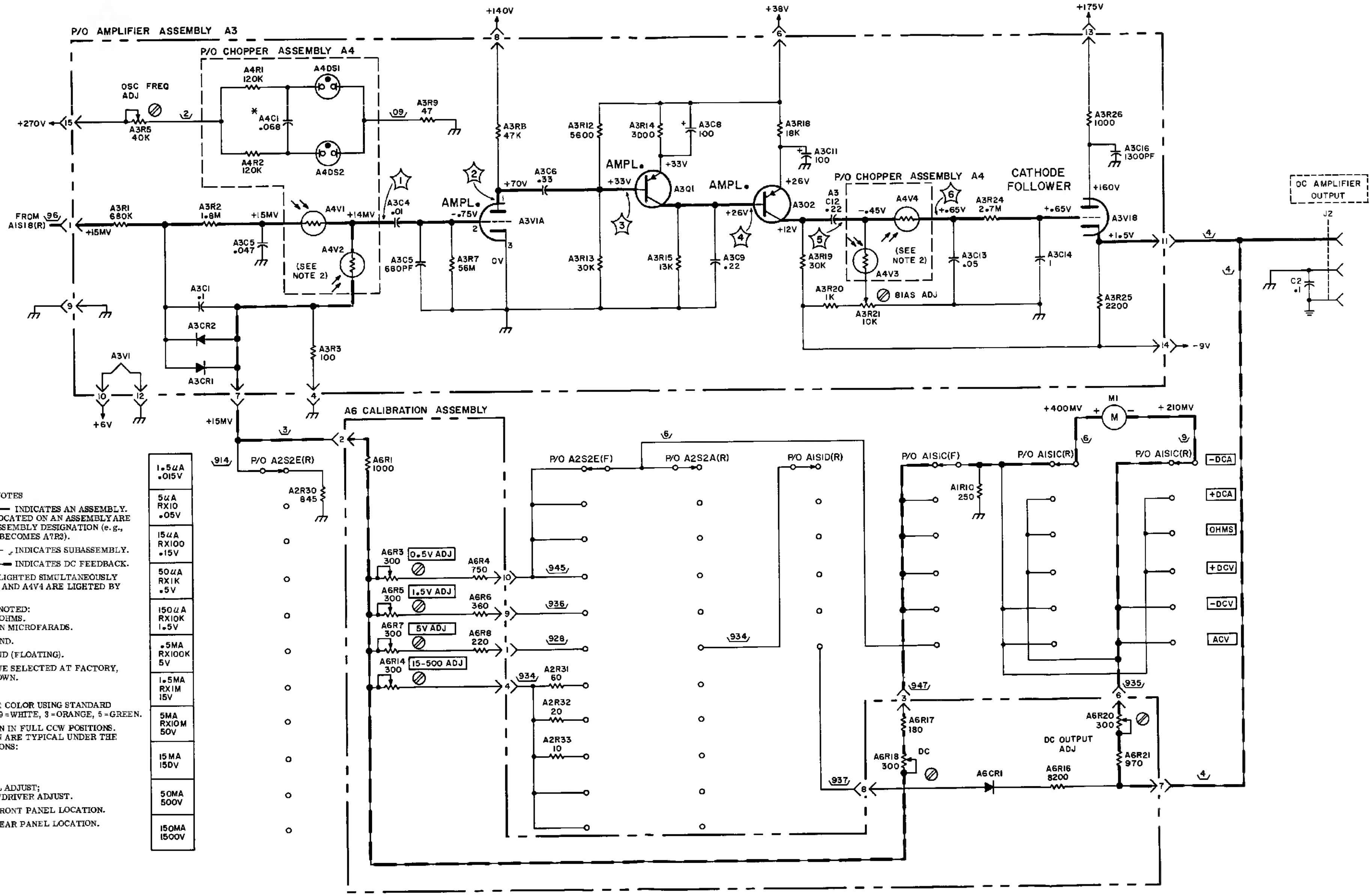


NOTES

1. ———— INDICATES AN ASSEMBLY. ALL COMPONENTS LOCATED ON AN ASSEMBLY ARE PREFIXED BY THE ASSEMBLY DESIGNATION (e.g., R2 ON ASSEMBLY A7 BECOMES A7R2).
2. ———— INDICATES SUBASSEMBLY.
3. ━━━━ INDICATES DC FEEDBACK.
4. A4V1 AND A4V3 ARE LIGHTED SIMULTANEOUSLY BY A4DS1, AND A4V2 AND A4V4 ARE LIGHTED BY A4DS2.
5. UNLESS OTHERWISE NOTED: RESISTANCE IS IN OHMS. CAPACITANCE IS IN MICROFARADS.
6. ⏚ = CABINET GROUND. ⏚ = CIRCUIT GROUND (FLOATING).
7. * = OPTIMUM VALUE SELECTED AT FACTORY, AVERAGE VALUE SHOWN.
8. P/O = PART OF.
9. 935 DENOTES WIRE COLOR USING STANDARD COLOR CODE. (e.g. 9=WHITE, 3=ORANGE, 5=GREEN.
10. SWITCHES ARE SHOWN IN FULL CCW POSITIONS.
11. DC VOLTAGES SHOWN ARE TYPICAL UNDER THE FOLLOWING CONDITIONS:
    FUNCTION: +DCV
    RANGE: .5 V
    INPUT: +0.5 V
12. ○ INDICATES PANEL ADJUST; ⊘ INDICATES SCREWDRIVER ADJUST.
13. ▭ INDICATES FRONT PANEL LOCATION. ┈ INDICATES REAR PANEL LOCATION.

Figure 5-10. Amplifier Schematic

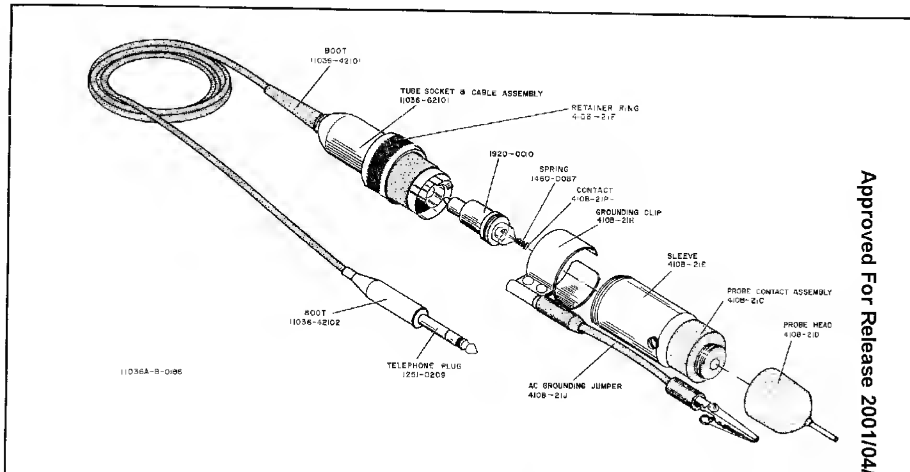
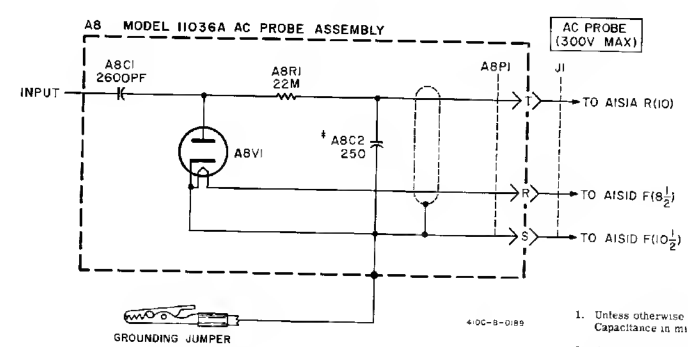


Figure 5-11. Model 11036A AC Probe (Exploded View)



NOTES

1. Unless otherwise specified, resistance in ohms. Capacitance in microfarads.
2. ‡ value of A8C2 includes probe lead capacity.
3. ---- indicates an assembly. All components located on any assembly are prefixed by the assembly designation (e.g. R1 on assembly A8 becomes A8R1).

Figure 5-12. Model 11036A AC Probe Schematic

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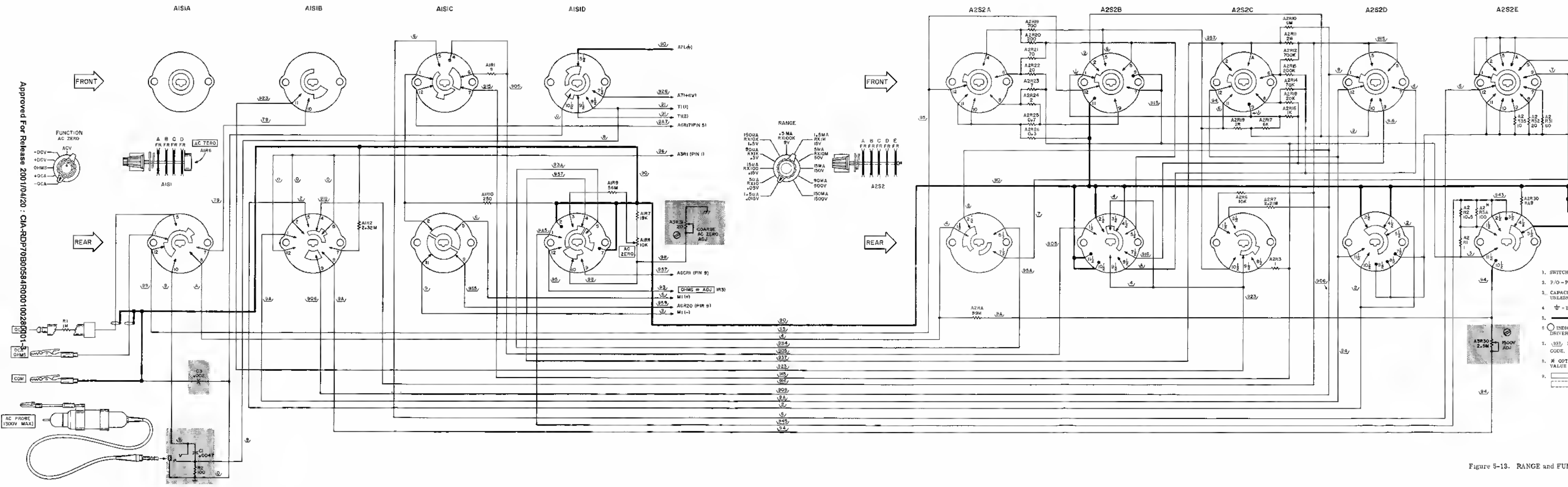

NOTES

1. SWITCHES ARE SHOWN IN FULL CCW POSITIONS
2. P/O = PART OF.
3. CAPACITANCE IN MICROFARADS AND RESISTANCE IN OHMS, UNLESS OTHERWISE SPECIFIED.
4. ⏚ = EARTH GROUND; ⏊ = CIRCUIT COMMON
5. ▬▬▬ INDICATES CIRCUIT GROUND BUSS.
6. ○ INDICATES PANEL ADJUST ⊘ INDICATES SCREW-DRIVER ADJUST
7. 937 INDICATES WIRE COLOR USING STANDARD COLOR CODE. (e.g., 9 = WHITE, 3 = ORANGE, 7 = VIOLET.)
8. ✱ OPTIMUM VALUE SELECTED AT FACTORY. AVERAGE VALUE SHOWN.
9. ▭ INDICATES FRONT PANEL LOCATION
   ⬚ INDICATES REAR PANEL LOCATION.

Figure 5-13. RANGE and FUNCTION Switching (Pictorial)

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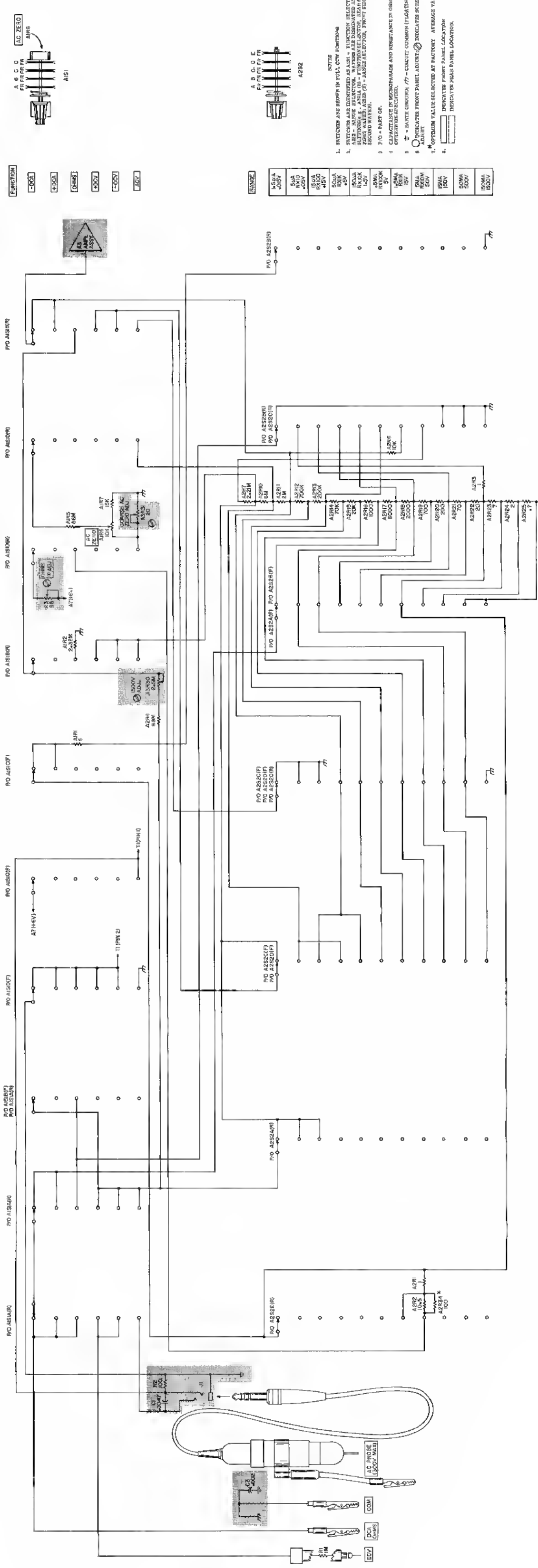

Figure 5-14. Input RANGE and FUNCTION Switching Schematic

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and ⓗⓟ stock number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their ⓗⓟ stock number and provides the following information on each part:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code (see list of manufacturers in Appendix).

c. Manufacturer's part number.

d. Total quantity used in the instrument (TQ column).

6-3. Replaceable hardware parts, not listed in Table 6-1 or 6-2, are listed in Table 6-3 in alphabetical order of description.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office (see lists at rear of this manual for addresses). Identify parts by their Hewlett-Packard stock numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor	FL	= filter	Q	= transistor	W	= cable
C	= capacitor	J	= jack	R	= resistor	X	= socket
CR	= diode	K	= relay	RT	= thermistor	XF	= fuseholder
DL	= delay line	L	= inductor	S	= switch	XDS	= lampholder
DS	= device signaling (lamp)	M	= meter	T	= transformer	Z	= network
E	= misc electronic part	MP	= mechanical part				

ABBREVIATIONS

a = amperes

bp = bandpass
bwo = backward wave oscillator

c = carbon
cer = ceramic
cmo = cabinet mount only
coef = coefficient
com = common
comp = composition
conn = connection
crt = cathode-ray tube

dep = deposited

EIA = Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by ⓗⓟ stock numbers.

elect = electrolytic
encap = encapsulated

f = farads
fxd = fixed

Ge = germanium
grd = ground (ed)
h = henries
Hg = mercury

impg = impregnated
incd = incandescent
ins = insulation (ed)

K = kilo = 1000

lin = linear taper
log = logarithmic taper

m = milli = 10^{-3}
M = megohms
ma = milliamperes
μ = micro = 10^{-6}
minat = miniature
mfgl = metal film on glass
mfr = manufacturer

mtg = mounting
my = mylar

NC = normally closed
Ne = neon
NO = normally open
NPO = negative positive zero (zero temperature coefficient)
nsr = not separately replaceable

obd = order by description

p = peak
pc = printed circuit board
pf = picofarads = 10^{-12} farads
pp = peak to peak
piv = peak inverse voltage
pos = position (s)
poly = polystyrene
pot = potentiometer
rect = rectifier

rot = rotary
rms = root-mean-square
rmo = rack mount only

s-b = slow-blow
Se = selenium
sect = section(s)
Si = silicon
sil = silver
sl = slide

td = time delay
TiO_2 = titanium dioxide

tog = toggle
tol = tolerance
trim = trimmer
twt = traveling wave tube

var = variable
w/ = with
W = watts
ww = wirewound
w/o = without

* = optimum value selected at factory, average value shown (part may be omitted)

Table 6-1 Reference Designation Index

REFERENCE DESIGNATION	ⓗ PART NO.	DESCRIPTION	NOTE
A1S1	410C-19B	Switch ass'y - selector, includes: R1, 2 R10 R5 thru 7 S1	
A1R1	0727-0004	R: fxd, dep c flm, 5 ohms ±1%, 1/2 w	
A1R2	0727-0480	R: fxd, carbon flm, 2.32 megohms ±1%, 0.5 w	
A1R3 and A1R4		Not Assigned	
A1R5	0687-5661	R: fxd, comp, 56 megohms ±10%, 1/2 w	
A1R6	2100-0389	R: var, ww, lin taper, 10 K ohms ±10%, 5 w	
A1R7	0687-1531	R: fxd, comp, 15 K ohms ±10%, 1/2 w	
A1R8 and A1R9		Not Assigned	
A1R10	0727-0479	R: fxd, carbon flm, 250 ohms ±1%, 1/2 w	
A2S2	410C-19A	Switch ass'y - range, includes: R1 thru 4 R30 thru 33 R6, 7 S2 R10 thru 26	
A2R1	0728-0004	R: fxd, carbon flm, 1 ohm ±1%, 1/2 w	
A2R2	0727-0955	R: fxd, carbon flm, 10.5 ohms ±1%, 1/2 w	
A2R3	0728-0004	R: fxd, carbon flm, 1 ohm ±1%, 1/2 w	
A2R4	0733-0018	R: fxd, carbon flm, 89 megohms ±1%, 2 w	
A2R5		Not Assigned	
A2R6	0687-1031	R: fxd, comp, 10 K ohms ±10%, 1/2 w	
A2R7	0727-0478	R: fxd, carbon flm, 2.21 megohms ±1%, 1/2 w	
A2R8 and A2R9		Not Assigned	
A2R10	0730-0176	R: fxd, 6 megohms ±0.5%, 1 w	
A2R11	0727-0459	R: fxd, carbon flm, 2 megohms ±0.5%, 1 w	
A2R12	0727-0458	R: fxd, carbon flm, 700 K ohms ±0.5%, 1/2 w	
A2R13	0727-0457	R: fxd, carbon flm, 200 K ohms ±1%, 1/2 w	
A2R14	0727-0456	R: fxd, carbon flm, 70 K ohms ±0.5%, 1/2 w	
A2R15	0727-0455	R: fxd, carbon flm, 20 K ohms ±0.5%, 1/2 w	
A2R16	0727-0451	R: fxd, carbon flm, 1 K ohm ±0.5%, 1/2 w	
A2R17	0727-0454	R: fxd, carbon flm, 6 K ohms ±0.5%, 1/2 w	
A2R18	0727-0453	R: fxd, carbon flm, 2 K ohms ±0.5%, 1/2 w	
A2R19	0727-0452	R: fxd, carbon flm, 700 ohms ±0.5%, 1/2 w	
A2R20	0727-0450	R: fxd, carbon flm, 200 ohms ±0.5%, 1/2 w	
A2R21	0727-0449	R: fxd, carbon flm,70 ohms ±1%, 1/2 w	
A2R22	0727-0448	R: fxd, carbon flm, 20 ohms ±1%, 1/2 w	
A2R23	0727-0446	R: fxd, carbon flm, 7 ohms ±1%, 1/2 w	
A2R24	0727-0445	R: fxd, carbon flm, 2 ohms ±1%, 1/2 w	
A2R25	410C-26B	R: fxd, 0.7 ohms	
A2R26	410C-26A	R: fxd, 0.3 ohms	
A2R27 thru A2R29		Not Assigned	
A2R30	0727-0701	R: fxd, carbon flm, 845 ohms ±1%, 1/2 w	
A2R31	0727-0031	R: fxd, carbon flm, 60 ohms ±1%, 1/2 w	
A2R32	0727-0448	R: fxd, carbon flm, 20 ohms ±1%, 1/2 w	
A2R33	0727-0948	R: fxd, carbon flm, 10 ohms ±1%, 1/2 w	
A2R34	0687-1011	R: fxd, comp, 100 ohms ±10%, 1/2 w	

/ See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	ⓗ PART NO.	DESCRIPTION	NOTE
A3	410C-65A	Board ass'y - amplifier, includes: C1, 2 — R1 thru 3 C4 thru 6 — R5 C8, 9 — R7 thru 9 C11 thru 14 — R12 thru 15 C16 — R18 thru 21 CR1, 2 — R24 thru 26 Q1, 2 — R30, 31 V1	
A3C1	0170-0030	C: fxd, poly, 0.1 µf ±10%, 50 vdcw	
A3C2	0170-0077	C: fxd, poly, 0.047 µf ±10%, 50 vdcw	
A3C3		Not Assigned	
A3C4	0160-0161	C: fxd, my, 0.01 µf, 200 vdcw	
A3C5	0140-0208	C: fxd, mica, 680 pf ±5%, 300 vdcw	
A3C6	0160-0209	C: fxd, my, 0.33 µf ±20%, 200 vdcw	
A3C7		Not Assigned	
A3C8	0180-0039	C: fxd, elect, 100 µf, 12 vdcw	
A3C9	0160-0200	C: fxd, my, 0.22 µf ±20%, 200 vdcw	
A3C10		Not Assigned	
A3C11	0180-0094	C: fxd, elect, 100 µf, 25 vdcw	
A3C12	0160-0200	C: fxd, my, 0.22 µf ±20%, 200 vdcw	
A3C13	0150-0096	C: fxd, cer, 0.05 µf, 100 vdcw	
A3C14	0170-0018	C: fxd, my, 1 µf ±5%, 200 vdcw	
A3C15		Not Assigned	
A3C16	0140-0154	C: fxd, mica, 1300 pf ±5%, 500 vdcw	
A3CR1 and A3CR2	1901-0156	Diode: si, 50 ma	
A3R1	0687-6841	R: fxd, comp, 680 K ohms ±10%, 1/2 w	
A3R2	0687-1851	R: fxd, comp, 1.8 megohms ±10%, 1/2 w	
A3R3	0811-0998	R: fxd, comp, 100 ohms ±1%, 1/4 w	
A3R4		Not Assigned	
A3R5	2100-0442	R: var, comp, lin taper, 40 K ohms ±30%, 1/4 w	
A3R6		Not Assigned	
A3R7	0687-5661	R: fxd, comp, 56 megohms ±10%, 1/2 w	
A3R8	0687-4731	R: fxd, comp 47 K ohms ±10%, 1/2 w	
A3R9	0687-4701	R: fxd, comp, 47 ohms ±10%, 1/2 w	
A3R10 and A3R11		Not Assigned	
A3R12	0757-0164	R: fxd, met flm, 5.6 K ohms ±2%, 1/2 w	
A3R13	0757-0166	R: fxd, met flm, 30 K ohms ±2%, 1/2 w	
A3R14	0757-0163	R: fxd, met flm, 3 K ohms ±2%, 1/2 w	
A3R15	0757-0165	R: fxd, met flm, 13 K ohms ±2%, 1/2 w	
A3R16 and A3R17		Not Assigned	
A3R18	0757-0091	R: fxd, met flm, 18 K ohms ±2%, 1/2 w	
A3R19	0757-0166	R: fxd, met flm, 30 K ohms ±2%, 1/2 w	
A3R20	0687-1021	R: fxd, comp, 1 K ohm ±10%, 1/2 w	
A3R21	2100-0396	R: var, ww, lin taper, 10 K ohms ±20%, 1 w	
A3R22 and A3R23		Not Assigned	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	ⓗ PART NO.	DESCRIPTION	NOTE
A3R24	0687-2751	R: fxd, comp, 2.7 megohms ±10%, 1/2 w	
A3R25	0687-2221	R: fxd, comp 2.2 K ohms ±10%, 1/2 w	
A3R26	0687-1021	R: fxd, comp, 1 K ohm ±10%, 1/2 w	
A3R27 thru A3R29		Not Assigned	
A3R30	2100-0413	R: var, comp, lin taper, 2.5 megohms ±20%, 1/4 w	
A3R31	2100-0227	R: var, ww, lin taper, 20 ohms ±10%, 1 w	
A3Q1	1850-0013	Transistor: germanium, PNP	
A3Q2	1850-0040	Tranasistor: germanimum, PNP	
A3V1	1932-0027	Tube: electron, dual triode, 12AT7	
A4	1990-0020	Ass'y - chopper block, includes: A4C1 A4R1, 2 A4DS1, 2 A5V1 thru 4	
A4C1		Not separately replaceable, part of chopper ass'y (1990-0020)	
A4DS1 and A4DS2		Not separately replaceable, part of chopper ass'y (1990-0020)	
A4R1 and A4R2		Not separately replaceable, part of chopper ass'y (1990-0020)	
A4V1 thru A4V2		Not separately replaceable, part of chopper ass'y (1990-0020)	
A6	410C-65B	Board ass'y - calibration, includes: CR1 R14 R1 R16 thru 18 R3 thru 8 R20, 21	
A6CR1	1901-0025	Diode: si, 50 ma	
A6R1	0727-0751	R: fxd, carbon flm, 1 K ohm ±1%, 1/2 w	
A6R2		Not Assigned	
A6R3	2100-0394	R: var, ww, lin taper, 300 ohms ±20%, 1 w	
A6R4	0727-0747	R: fxd, carbon flm, 750 ohms ±1%, 1/2 w	
A6R5	2100-0394	R: var, ww, lin taper, 300 ohms ±20%, 1 w	
A6R6	0728-0011	R: fxd, carbon flm, 360 ohms ±1%, 1/2 w	
A6R7	2100-0394	R: var, ww, lin taper, 300 ohms ±20%, 1 w	
A6R8	0728-0010	R: fxd, carbon flm, 220 ohms ±1%, 1/2 w	
A6R9 thru A6R13		Not Assigned	
A6R14	2100-0394	R: var, ww, lin taper, 300 ohms ±20%, 1 w	
A6R15		Not Assigned	
A6R16	0758-0048	R: fxd, met flm, 8.2 K ohms ±5%, 1/2 w	
A6R17	0727-0866	R: fxd, carbon flm, 180 ohms ±1%, 1/2 w	
A6R18	2100-0394	R: var, ww, lin taper, 300 ohms ±20%, 1 w	
A6R19		Not Assigned	
A6R20	2100-0395	R: var, comp, lin taper, 300 ohms ±20%, 1/4 w	
A6R21	0727-0475	R: fxd, deposit carbon, 970 ohms ±0.5%, 1/2 w	

☆ See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	ⓗ PART NO.	DESCRIPTION	NOTE
A7	410C-65C	Board ass'y - power supply, includes: C1 R1 thru 4 CR6, 8 R7, 8, 10	
A7C1	0140-0041	C: fxd, mica, 100 pf ±5%, 500 vdcw	
A7CR1 thru A7CR5		Not Assigned	
A7CR6	1902-0026	Diode: breakdown junction, 36.5 v ±10%, 0.4 w	
A7CR7		Not Assigned	
A7CR8	1902-0049	Diode: breakdown junction, 6.19 v ±5%, 0.4 w	
A7R1 and A7R2	0764-0003	R: fxd, met flm, 3.3 K ohms ±5%, 2 w	
A7R3	0758-0018	R: fxd, met flm, 15 K ohms ±5%, 1/2 w	
A7R4	0764-0026	R: fxd, met flm, 13 K ohms ±5%, 2 w	
A7R5 and A7R6		Not Assigned	
A7R7	0758-0069	R: fxd, met flm, 1.1 K ohm ±5%, 1/2 w	
A7R8	0758-0070	R: fxd, met flm, 1.2 K ohms ±5%, 1/2 w	
A7R9		Not Assigned	
A7R10	0758-0083	R: fxd, met flm, 68 ohms ±5%, 1/2 w	
A8	11036A	AC Probe ass'y (ⓗ Model 11036A, complete) C1, 2 R1 P1 V1	
A8C1		Not separately replaceable, part of AC Probe ass'y (11036A)	
A8C2		Not separately replaceable, part of AC Probe ass'y (11036A)	
A8P1	1251-0209	Plug: telephone, 3 conductor	
A8R1		Not separately replaceable, part of AC Probe ass'y (11036A)	
A8V1	1920-0010	Tube: electron, EA53, diode	
C1	0170-0021	C: fxd, my, 4700 pf ±10%, 400 vdcw	
C2	0160-0001	C: fxd, my, 0.1 μf ±10%, 600 vdcw	
C3	0150-0023	C: fxd, ceramic, 2000 pf ±20%, 1000 vdcw	
C4		Not Assigned	
C5	0180-0125	C: fxd, elect, 4 sect, 4 x 20 μf, 450 vdcw	
C6	0180-0153	C: fxd, elect, 2 sect, 2 x 1200 μf, 20 vdcw	
CR1 and CR2	1901-0036	Diode: si, 300 ma	
CR3 and CR4	1901-0049	Diode: si, 500 ma	
CR5 and CR6		Not Assigned	
CR7	1902-0327	Diode: breakdown junction, 9.09 v ±10%, 1.5 w	
DS1	1450-0106	Light Indicator: A1C neon (p/o S3)	
F1	2110-0018	Fuse: cartridge, slo-blo, 0.25 amp, 125 v	

See introduction to this section

Table 6-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	ⓗⓟ PART NO.	DESCRIPTION	NOTE
J1	1251-0200	Jack: telephone, 3 conductor	
J2		Not Assigned	
J3	1251-0148	Connect: power cord receptacle	
M1	1120-0317	Meter: 0-1 ma	
Q1	1850-0098	Transistor: germanium, PNP	
R1	0727-0274	R: fxd, carbon flm, 1 megohm ±1%, 1/2 w	
R2	0758-0086	R: fxd, met flm, 100 ohms ±5%, 1/4 w	
R3	2100-0415	R: var, ww, lin taper, 25 ohms ±10%, 2 w	
R4		Not Assigned	
R5	0687-6831	R: fxd, comp, 68 K ohms ±10%, 1/2 w	
S3	3101-0100	Switch: SPST, pushbutton, w/pilot light	
S4	3101-0033	Switch: DPDT, slide	
T1	9100-0174	Transformer: power	
W1	8120-0078	Cable, Power: 3 conductor, 7-1/2 ft. long, w/NEMA plug	
XQ1	1200-0044	Socket, transistor: TO-3	

See introduction to this section

01566-3

Table 6-2. Replaceable Parts

ℎ𝑝 PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
410C-19A	Switch ass'y - range, includes: R1 thru 4 R30 thru 33 R6, 7 S2 R10 thru 26	28480	410C-19A	1	
410C-19B	Switch ass'y - selector, includes: R1, 2 R10 R5 thru 7 S1	28480	410C-19B	1	
410C-26A	R: fxd, 0.3 ohms	28480	410C-26A	1	
410C-26B	R: fxd, 0.7 ohms	28480	410C-26B	1	
410C-65A	Board ass'y-amplifier, includes: C1, 2 R7 thru 9 C4 thru 6 R12 thru 15 C8, 9 R18 thru 21 C11 thru 14 R24 thru 26 C16 R30 CR1, 2 Q1, 2 R1 thru 3 V1 R5	28480	410C-65A	1	
410C-65B	Board ass'y - calibrator, includes: CR1 R14 R1 R16 thru 18 R3 thru 8 R20, 21	28480	410C-65B	1	
410C-65C	Board ass'y - power supply, includes: C1 R1 thru 4 CR6, 8 R7, 8, 10	28480	410C-65C	1	
0140-0041	C: fxd, mica, 100 pf ±5%, 500 vdcw	04062	RCM15E101J	1	
0140-0154	C: fxd, mica, 1300 pf ±5%, 500 vdcw	14655	RCM15E101K	1	
0140-0208	C: fxd, mica, 680 pf ±5%, 300 vdcw	00853	obd #	1	
0150-0023	C: fxd, ceramic, 2000 pf ±20%, 100 vdcw	56289	19C203A	1	
0150-0096	C: fxd, ceramic, 0.05 μf, 100 vdcw	72982	845-X5V-5032	1	
0160-0001	C: fxd, my 0.1 μf ±10%, 600 vdcw	56289	160P10496	1	
0160-0161	C: fxd, my, 0.01 μf, 200 vdcw	56289	192P10392	1	
0160-0200	C: fxd, my, 0.22 μf ±20%, 200 vdcw	72354	F307C224M	2	
0160-0209	C: fxd, my, 0.33 μf ±20%, 200 vdcw	72354	F307C334M	1	
0170-0018	C: fxd, my, 1 μf ±5%, 200 vdcw	84411	Hew 4/	1	
0170-0021	C: fxd, my, 4700 pf ±10%, 400 vdcw	84411	620SJ0047	1	
0170-0030	C: fxd, poly, 0.1 μf ±10%, 50 vdcw	56289	P136072	1	
0170-0077	C: fxd, poly, 0.047 μf ±10%, 50 vdcw	56289	P130649	1	
0180-0039	C: fxd, elect, 100 μf, 12 vdcw	56289	D32697	1	
0180-0094	C: fxd, elect, 100 μf, 25 vdcw	56289	30D107G025H4	1	
0180-0125	C: fxd, elect, 4 sect, 4 x 20 μf, 450 vdcw	00853	Type PLI	1	
0180-0153	C: fxd, elect, 2 sect, 2 x 1200 μf, 20 vdcw	00853	4S4039	1	
0686-1021	R: fxd, comp, 1 K ohm ±10%, 1/2 w	01121	EB1021	1	
0687-1011	R: fxd, comp, 100 ohms ±10%, 1/2 w	01121	EB1011	1	
0687-1021	R: fxd, comp, 1 K ohm ±10%, 1/2 w	01121	EB1021	2	

\# See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

ⓗ PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
0687-1031	R: fxd, comp, 10 K ohms ±10%, 1/2 w	01121	EB1031	1	
0687-1531	R: fxd, comp, 15 K ohms ±10%, 1/2 w	01121	EB1531	1	
0687-1851	R: fxd, comp, 1.8 megohms ±10%, 1/2 w	01121	EB1851	1	
0687-2221	R: fxd, comp, 2.2 K ohms ±10%, 1/2 w	01121	EB2221	1	
0687-2751	R: fxd, 2.7 megohms ±10%, 1/2 w	01121	EB2751	1	
0687-4701	R: fxd, comp, 47 ohms ±10%, 1/2 w	01121	EB4701	1	
0687-4731	R: fxd, comp, 47 K ohms ±10%, 1/2 w	01121	EB4731	1	
0687-5661	R: fxd, comp, 56 megohms ±10%, 1/2 w	01121	EB5661	2	
0687-6831	R: fxd, comp, 68 K ohms ±10%, 1/2 w	01121	EB6831	1	
0687-6841	R: fxd, comp, 680 K ohms ±10%, 1/2 w	01121	EB6841	1	
0727-0004	R: fxd, deposit carbon flm, 5 ohms ±1%, 1/2 w	94459	CVS	1	
0727-0031	R: fxd, carbon flm, 60 ohms ±1%, 1/2 w	01295	DC1/2PR	1	
0727-0274	R: fxd, carbon flm, 1 megohm ±1%, 1/2 w	94459	CVF	1	
0727-0445	R: fxd, carbon flm, 2 ohms ±1%, 1/2 w	94459	CVS	1	
0727-0446	R: fxd, carbon flm, 7 ohms ±1%, 1/2 w	94459	CVS	1	
0727-0448	R: fxd, carbon flm, 20 ohms ±1%, 1/2 w	94459	CVF	2	
0727-0449	R: fxd, carbon flm, 70 ohms ±1%, 1/2 w	94459	CVF	1	
0727-0450	R: fxd, carbon flm, 200 ohms ±0.5%, 1/2 w	94459	CVF	1	
0727-0451	R: fxd, carbon flm, 1 K ohm ±0.5%, 1/2 w	94459	CVF	1	
0727-0452	R: fxd, carbon flm, 700 ohms ±0.5%, 1/2 w	94459	CVF	1	
0727-0453	R: fxd, carbon flm, 2 K ohms ±0.5%, 1/2 w	94459	CVF	1	
0727-0454	R: fxd, carbon flm, 6 K ohms ±0.5%, 1/2 w	94459	CVF	1	
0727-0455	R: fxd, carbon flm, 20 K ohms ±0.5%, 1/2 w	94459	CVF	1	
0727-0456	R: fxd, carbon flm, 70 K ohms ±0.5%, 1/2 w	94459	CVF	1	
0727-0457	R: fxd, carbon flm, 200 K ohms ±1%, 1/2 w	94459	CVF	1	
0727-0458	R: fxd, carbon flm, 700 K ohms ±0.5%, 1/2 w	94459	CVF	1	
0727-0459	R: fxd, carbon flm, 2 megohms ±0.5%, 1 w	01295	CD1R	1	
0727-0475	R: fxd, deposit carbon, 970 ohms ±0.5%, 1/2 w	94459	CD1/2MR	1	
0727-0478	R: fxd, carbon flm, 2.21 megohms ±1%, 1/2 w	94459	CVF	1	
0727-0479	R: fxd, carbon flm, 250 ohms ±1%, 1/2 w	94459	CVF	1	
0727-0480	R: fxd, carbon flm, 2.32 megohms ±1%, 0.5 w	94459	CVF	1	
0727-0701	R: fxd, carbon flm, 845 ohms ±1%, 1/2 w	94459	CVF	1	
0727-0747	R: fxd, carbon flm, 750 ohms ±1%, 1/2 w	94459	CVF	2	
0727-0751	R: fxd, carbon flm, 1 K ohm ±1%, 1/2 w	94459	CVF	1	
0727-0866	R: fxd, carbon flm, 180 ohms ±1%, 1/2 w	94459	CVF	1	
0727-0948	R: fxd, carbon flm, 10 ohms ±1%, 1/2 w	94459	CVF	1	
0727-0955	R: fxd, carbon flm, 10.5 ohms ±1%, 1/2 w	94459	CVF	1	
0728-0004	R: fxd, carbon flm, 1 ohm ±1%, 1/2 w	94459	CVF	2	
0728-0010	R: fxd, carbon flm, 220 ohms ±1%, 1/2 w	94459	CVS	1	
0728-0011	R: fxd, carbon flm, 360 ohms ±1%, 1/2 w	94459	CVF	1	
0730-0176	R: fxd, 6 megohms ±0.5%, 1 w	94459	CVC	1	
0733-0018	R: fxd, carbon flm, 89 megohms ±1%, 2 w	03888	HV2000	1	
0757-0091	R: fxd, met flm, 18 K ohms ±2%, 1/2 w	07115	C20	1	
0757-0163	R: fxd, met flm, 3 K ohms ±2%, 1/2 w	07115	C20	1	
0757-0164	R: fxd, met flm, 5.6 K ohms ±2%, 1/2 w	07115	C20	1	
0757-0165	R: fxd, met flm, 13 K ohms ±2%, 1/2 w	07115	C20	1	
0757-0166	R: fxd, met flm, 30 K ohms ±2%, 1/2 w	07115	C20	2	
0758-0018	R: fxd, met flm, 15 K ohms ±5%, 1/2 w	07115	C20	1	
0758-0048	R: fxd, met flm, 8.2 K ohms ±5%, 1/2 w	07115	C20	1	

ⓗ See introduction to this section

Table 6-2. Replaceable Parts (Cont'd)

ℎ𝑝 PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
0758-0069	R: fxd, met flm, 1.1 K ohm ±5%, 1/2 w	07115	C20	1	
0758-0070	R: fxd, met flm, 1.2 K ohms ±5%, 1/2 w	07115	C20	1	
0758-0083	R: fxd, met flm, 68 ohms ±5%, 1/2 w	07115	C20	1	
0758-0086	R: fxd, met flm, 100 ohms ±5%, 1/4 w	07115	C07	1	
0764-0003	R: fxd, met flm, 3.3 K ohms ±5%, 2 w	07115	C42S	1	
0764-0026	R: fxd, met flm, 13 K ohms ±5%, 2 w	07115	C42S	1	
0811-0998	R: fxd, comp, 100 ohms ±1%, 1/4 w	28480	0811-0998	1	
1120-0317	Meter: 0 - 1 ma	28480	1120-0317	1	
1200-0044	Socket, transistor: TO-3	97913	M7 (PB)	1	
1251-0148	Connector, power cord receptacle	82389	AC3G	1	
1251-0200	Jack: telephone, 3 conductor	82389	3J-1291	1	
1251-0209	Plug: telephone, 3 conductor	82389	2P-1297	1	
1450-0106	Light Indicator: A1C neon (p/o S3)	87034	A1C	1	
1850-0013	Transistor: germanium, PNP	86684	CP2366	1	
1850-0040	Transistor: germanium, PNP	04713	SA591	1	
1850-0098	Transistor: germanium, PNP	83298	B-1493	1	
1901-0025	Diode: si, 50 ma	93332	D3C72	1	
1901-0036	Diode: si, 300 ma	01841	obd #	1	
1901-0049	Diode: si, 500 ma	86684	34934	1	
1901-0156	Diode: si, 50 ma	03877	SG3288	1	
1902-0026	Diode: breakdown, junction, 36.5 v ±10%, 0.4 w	04713	SZ10939-343	1	
1902-0049	Diode: breakdown, junction, 6.19 v ±5%, 0.4 w	04713	SZ10939-122	1	
1902-0327	Diode: breakdown, junction, 9.09 v ±10%, 1.5 w	12954	obd #	1	
1920-0010	Tube electron, EA53, diode	73445	EA53	1	
1932-0027	Tube: electron, 12AT7, dual triode	000I1	2AT7	1	
1990-0020	Ass'y - chopper block, includes: C1, R1, 2, DS1, 2, V1 thru 4	28480	1990-0020	1	
2100-0227	R: var, ww, lin taper, 20 ohms ±10%, 1 w	28480	2100-0227	1	
2100-0389	R: var, ww, lin taper, 10 K ohms ±10%, 5 w	28480	2100-0389	1	
2100-0394	R: var, ww, lin taper, 300 ohms ±20%, 1 w	11236	Series 110	6	
2100-0395	R: var, comp, lin taper, 300 ohms ±20%, 1/4 w	71590	Series 5, Type 70-1	1	
2100-0396	R: var, ww, lin taper, 10 K ohms ±20%, 1 w	79727	E870PAB	1	
2100-0413	R: var, comp, lin taper, 2.5 megohms ±20%, 1/4 w	71590	Series 5, Type 70-1	1	
2100-0415	R: var, comp, lin taper, 25 ohms ±10%, 2 w	08984	FFF-1, Term. X, Y, Z	1	
2100-0442	R: var, comp, lin taper, 40 K ohms ±30%, 1/4 w	71590	Series 5, Type 70-1	1	
2110-0018	Fuse: cartridge, slo-blo, 0.25 amp, 125 v	71400	MDL1/4	1	
3101-0033	Switch: slide, DPDT	79727	G-326, 6510 Rev. A	1	
3101-0100	Switch: SPST, pushbutton, w/pilot light	87034	SW-624-109	1	
8120-0078	Cable, Power: 3 conductor, 7-1/2 ft. long, w/NEMA plug	70903	KH-4147	1	
9100-0174	Transformer: power	28480	9100-0174	1	

See introduction to this section

Approved For Release 2001/04/20 : CIA-RDP70B00584R000100280001-3

Table 6-3. Replaceable Hardware

ⓗⓟ PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
1510-0006	Binding post, black (p/o J2)	28480	1510-0006	1	
1510-0007	Binding post, red (p/o J2)	28480	1510-0007	2	
11036-42102	Boot, AC plug (p/o 11036A)	28480	11036-42102	1	
11036-42101	Boot, AC probe (p/o 11036A)	28480	11036-42101	1	
412A-83A	Boot, cable	28480	412A-83A	3	
410C-12A	Bracket, connector (used with A3 connector)	28480	410C-12A	1	
410C-12B	Bracket, switch (used with A6 connector)	28480	410C-12B	1	
1200-0081	Bushing, insulator (used with Q1)	26365	974 Special	2	
1410-0091	Bushing, panel (used with A1S1 and A2S2)	28520	SB-437-4	2	
0400-0019	Bushing, strain relief	28480	0400-0019	3	
410C-1A	Chassis, xfmr	28480	410C-1A	1	
410B-21H	Clip, grounding (p/o 11036A)	28480	410B-21H	1	
1251-0195	Connector, 10 pin P. C.	02660	143-010-09 (109)	1	
1251-0213	Connector, 15 pin P. C.	000XX	SD-615W (125)	1	
410B-21P	Contact, Diode (p/o 11036A)	28480	410B-21P	1	
3130-0038	Coupler, switch	45255	10X20X1	1	
5000-0711	Cover, bottom	28480	5000-0711	1	
5000-0703	Cover, side	28480	5000-0703	2	
5060-0706	Cover, top	28480	5060-0706	1	
5060-0727	Foot Ass'y	28480	5060-0727	2	
5060-0703	Frame, side	28480	5060-0703	2	
410B-21J	Ground Lead Ass'y (p/o 11036A)	28480	410B-21J	1	
5040-0700	Hinge (used with tilt stand)	28480	5040-0700	2	
1400-0084	Holder, fuse	75915	342014	1	
0340-0086	Insulator, binding post, double	28480	0340-0086	1	
0340-0091	Insulator, binding post, triple	28480	0340-0091	1	
1520-0001	Insulator, capacitor (used with C1 - C2)	56137	XP	2	
0340-0007	Insulator, ceramic standoff	71590	obd#	1	
0370-0112	Knob, black bar, concentric	28480	0370-0112	1	
0370-0113	Knob, black bar, w/arrow	28480	0370-0113	1	
0370-0114	Knob, red, w/arrow	28480	0370-0114	1	
0360-0016	Lug, solder, lock, #4	78452	718	1	
0360-0007	Lug, solder, #10	78189	2501-10-00	4	
0360-0042	Lug, solder, 90^{o}	79963	obd#	2	
2260-0001	Nut, hex, 4-40 x 1/4 in.	28480	2260-0001	4	
2420-0001	Nut, hex, 6-32 x 5/16 in., w/lock	83385	obd#	4	
2820-0001	Nut, hex, 10-32 x 3/8 in.	73743	obd#	3	
2950-0006	Nut, hex, 1/4-32 x 3/8 in.	73734	#9000	3	
2950-0001	Nut, hex, 3/8-32 x 1/2 in.	73743	obd#	3	
2950-0037	Nut, hex, 1/2-16 x 11/16 in.	75915	obd#	1	
2950-0038	Nut, hex, 1/2-24 x 11/16 in.	75915	903-12	1	
0590-0039	Nut, speed, 6-32	78553	C6800-632-1	4	
0590-0052	Nut, speed, 6-32	78553	C8020-632-4	2	
410C-2A	Panel, front	28480	410C-2A	1	
410C-2B	Panel, rear	28480	410C-2B	1	
410C-41A	Plate, insulator (used with A1S1 and A2S2)	28480	410C-41A	1	

See introduction to this section

Table 6-3. Replaceable Hardware (Cont'd)

PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
1200-0043	Plate, insulator (used with Q1)	71785	294457	1	
1251-0209	Plug, telephone (p/o 11036A)	82389	2P-1297	1	
410B-21C	Probe contact ass'y	28480	410B-21C	1	
410B-21D	Probe head	28480	410B-21D	1	
410B-21F	Ring, retainer (p/o 11036A)	28480	410B-21F	1	
2200-0006	Screw, machine, 4-40 x 3/8 in. RH	80120	obd#	2	
2200-0014	Screw, machine, 4-40 x 9/16 in. RH	80120	obd#	2	
2370-0001	Screw, machine, 6-32 x 1/4 in. FH	80120	obd#	20	
2390-0007	Screw, machine, 6-32 x 5/16 in. BH, w/lock	83385	obd#	4	
2370-0002	Screw, machine, 6-32 x 3/8 in. FH	80120	obd#	8	
2370-0003	Screw, machine, 6-32 x 1/2 in. FH	80120	obd#	2	
410B-21E	Sleeve (p/o 11036A)	28480	410B-21E	1	
1460-0087	Spring, diode contact (p/o 11036A)	91260	obd#	1	
1490-0031	Stand, tilt	91260	obd#	1	
410C-66A	Support, circuit board (used with A3)	28480	410C-66A	2	
410C-21D	Test lead ass'y, COM	28480	410C-21D	1	
410C-21C	Test lead ass'y, DCA-OHMS	28480	410C-21C	1	
410C-21A	Test lead ass'y, DCV (includes R1)	28480	410C-21A	1	
5020-0704	Trim, meter	28480	5020-0704	1	
11036-62101	Tube, socket and cable ass'y (p/o 11036A)	28480	11036-62101	1	
3050-0066	Washer, flat, #6	73734	obd#	2	
3050-0067	Washer, flat, 3/8 in. ID	73734	obd#	3	
0900-0016	Washer, fuse holder	76680	622710	1	
2190-0005	Washer, lock, #4 external	80120	obd#	2	
2190-0004	Washer, lock, #4 internal	78189	SF1904	2	
2190-0003	Washer, lock, #4 split	83385	obd#	2	
2190-0047	Washer, lock, #6 countersunk	78189	obd#	30	
2190-0011	Washer, lock, #10 internal	78189	1910	2	
2190-0028	Washer, lock, #10 int/ext	78189	4010-18-00	2	
2190-0027	Washer, lock, 1/4 in. internal	78189	1914	3	
2190-0022	Washer, lock, 3/8 in. ID	78189	1920	4	
2190-0037	Washer, lock, 1/2 in. internal	78189	1224-08	2	
1400-0090	Washer, Neoprene	75915	901-2	1	

See introduction to this section

APPENDIX

CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humidial Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc	Burlington, Wis.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp of America	Saugerties, N.Y
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol Borg Electronics Corp.	Chicago Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville N.J.
02771	Vocaline Co of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc., Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04777	Automatic Electric Sales Corp.	Northlake, Ill.
04796	Sequoia Wire & Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P. M. Motor Company	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metropolitan Telecommunications Corp., Metro Cap. Division	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc	Wakefield, Mass
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago Ill.
06540	Amatom Electronic Hardware Co Inc	New Rochelle, N.Y
06555	Beede Electrical Instrument Co. Inc.	Penacook, N.H.
06751	U.S. Semcor Division of Nuclear Corp. of America	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Birtcher Corp	Los Angeles, Calif.
07700	Technical Wire Products	Springfield N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada.
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co. Phoenix Div	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S., Inc	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atohm Electronics	Sun Valley, Calif.
09250	Electro Assemblies Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd	Toronto, Ontario, Canada
09664	The Bristol Co	Waterbury, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc	Berkeley, Calif.
10646	Carborundum Co	Niagara Falls, N.Y.
11236	CTS of Berne Inc	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronic Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermolloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15909	The Daven Co	Livingston, N.J.
16037	Spruce Pine Mica Co	Spruce Pine, N.C.
16352	Computer Diode Corp	Lodi, N.J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
37196	Stanwyck Coil	Hawkesbury, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
63743	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas & Betts Co.	Elizabeth 1, N.J.
60741	Triplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc	New York, N.Y
70319	Allmetal Screw Prod. Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72092	Eitel-McCullough Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
71707	Coto Coil Co., Inc.	Providence, R.I.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp., Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co. Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	So. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littelfuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostron Instrument and Electronic Co.	South Pasadena, Calif.
77250	Phaell Mfg. Co.	Chicago, Ill.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association, Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W.L. Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammerlund Co., Inc	New York, N.Y.
80640	Stevens, Arnold, Co. Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.
81349	Military Specification	....
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Div	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.

00015-37
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APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

Code No.	Manufacturer	Address
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	Seattle, Wash.
87930	Tower Mfg. Corp	Providence, R. I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88270	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Inc. Co.	Oakland, Calif.
89473	General Electric Distributing Corp.	Schenectady, N.Y
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers', Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Ill.
92180	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith Inc	Port Monmouth, N. J.
93979	G. V. Controls	Livingston, N. J.
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc	Loveland, Colo
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94222	Southco Div. of S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordas Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp of Calif.	Newbury Park, Calif.

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

Code No.	Manufacturer	Address
C0000	JFD Electronics Corp.	Van Nuys, Calif.
G0000	Tranex Company	Mountain View, Calif.
I0000	Western Devices, Inc.	Inglewood, Calif.
J0000	Winchester Electronics, Inc.	Santa Monica, Calif.
0000F	Malco Tool and Die	Los Angeles, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000AB	ETA	England
000AC	Indiana General Corp., Elect. Div.	Indiana
000AD	Curtis Instrument Inc.	Mt. Kisco, N.Y.
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Manufacturing Co.	San Jose 27, Calif.
000QQ	Cooltron	Oakland, Calif.
000RR	Radio Industries	Des Plaines, Ill.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000WW	California Eastern Lab.	Burlingame, Calif.
000XX	Methode Electronics, Inc.	Chicago 31, Ill.
000YY	S.K. Smith Co.	Los Angeles 45, Calif.

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SALES AND SERVICE OFFICES IN THE U.S. AND CANADA

ALABAMA

Huntsville, 35801
Hewlett Packard
Southern Sales Division
Holiday Office Ctr., Suite 18
(205) 881-4591
TWX: 510-579-2204

ARIZONA

Scottsdale, 85251
Hewlett-Packard
Neely Sales Division
3009 No. Scottsdale Rd.
(602) 945-7601
TWX: 602-949-0111

Tucson, 85716
Hewlett-Packard
Neely Sales Division
232 So. Tucson Blvd.
(602) 623-2564
TWX: 602-792-2759

CALIFORNIA

Los Angeles Area
Hewlett-Packard
Neely Sales Division
3939 Lankershim Blvd.
North Hollywood 91604
(213) 877-1282 and 766-3811
TWX: 910-499-2170

Sacramento, 95821
Hewlett-Packard
Neely Sales Division
2591 Carlsbad Ave.
(916) 482-1463
TWX: 916-444-8683

San Diego, 92106
Hewlett-Packard
Neely Sales Division
1055 Shafter Street
(714) 223-8103
TWX-714-276-4263

San Francisco Area
Hewlett-Packard
Neely Sales Division
501 Laurel Street
San Carlos 94071
(415) 591-7661
TWX: 910-376-4390

COLORADO

Englewood, 80110
Hewlett-Packard
Lahana Sales Division
7965 East Prentice
(303) 771-3455
TWX: 303-771-3056

CONNECTICUT

Middletown, 06458
Hewlett-Packard
Yewell Sales Division
589 Saybrook Rd.
(203) 346-6611
TWX: 203-346-7433

FLORIDA

Miami, 33125
Hewlett-Packard
Florida Sales Division
2907 Northwest 7th St.
(305) 635-6461

Orlando, 32803
Hewlett-Packard
Florida Sales Division
621 Commonwealth Ave.
(305) 425-5541
TWX: 305-275-1234

St. Petersburg, 33708
Hewlett-Packard
Florida Sales Division
410-150th Ave., Madeira Beach
(813) 391-0211
TWX: 813-391-0666

GEORGIA

Atlanta, 30305
Hewlett-Packard
Southern Sales Division
3110 Maple Drive, N. E.
(404) 233-1141
TWX: 810-751-3283

ILLINOIS

Chicago, 60645
Hewlett-Packard
Crossley Sales Division
2501 West Peterson Ave.
(312) 275-1600
TWX: 910-221-0277

INDIANA

Indianapolis, 46205
Hewlett-Packard
Crossley Sales Division
3919 Meadows Dr.
(317) 546-4891
TWX: 317-635-4300

KENTUCKY

Louisville, 40218
Hewlett-Packard
Southern Sales Division
Suite 4, 3411 Bardstown Rd.
(502) 459-4140
TWX: 810-535-3128

MARYLAND

Baltimore, 21207
Hewlett-Packard
Horman Sales Division
6660 Security Blvd.
(301) 944-5400

Washington, D. C. Area
Hewlett-Packard
Horman Sales Division
941 Rollins Avenue
Rockville 20852
(301) 427-7560
TWX: 710-828-9684

MASSACHUSETTS

Boston Area
Hewlett-Packard
Yewell Sales Division
Middlesex Turnpike
Burlington 01804
(617) 272-9000
TWX: 710-332-0382

MICHIGAN

Detroit, 48235
Hewlett-Packard
Crossley Sales Division
14425 West Eight Mile Road
(313) 342-5700
TWX: 313-342-0702

MINNESOTA

St. Paul, 55114
Hewlett-Packard
Crossley Sales Division
842 Raymond Avenue
(612) 646-7881
TWX: 612-551-0055

MISSOURI

Kansas City, 64131
Harris-Hanson Company
7916 Paseo Street
(816) 444-9494
TWX: 816-556-2423

St. Louis, 63144
Harris-Hanson Company
2814 South Brentwood Blvd.
(314) 647-4350
TWX: 314-962-3933

NEW JERSEY

Asbury Park Area
Hewlett-Packard
Robinson Sales Division
Shrewsbury
(201) 747-1060

Englewood, 07631
Hewlett-Packard
RMC Sales Division
391 Grand Avenue
(201) 567-3933

NEW MEXICO

Albuquerque, 87108
Hewlett-Packard
Neely Sales Division
6501 Lomas Blvd., N. E.
(505) 255-5586
TWX: 505-243-8314

Las Cruces, 88001
Hewlett-Packard
Neely Sales Division
114 S. Water Street
(505) 526-2486
TWX: 505-524-2671

NEW YORK

New York, 10021
Hewlett-Packard
RMC Sales Division
236 East 75th Street
(212) 879-2023
TWX: 710-581-4376

Rochester, 14625
Hewlett-Packard
Syracuse Sales Division
800 Linden Avenue
(716) 381-4120
TWX: 716-221-1514

Poughkeepsie, 12601
Hewlett-Packard
Syracuse Sales Division
82 Washington St.
(914) 454-7330
TWX: 914-452-7425

Syracuse, 13211
Hewlett-Packard
Syracuse Sales Division
Pickard Bldg., E. Molloy Rd.
(315) 454-2486
TWX: 315-477-1375

NORTH CAROLINA

High Point, 27262
Hewlett-Packard
Southern Sales Division
1923 N. Main Street
(919) 882-6873
TWX: 510-926-1516

OHIO

Cleveland, 44129
Hewlett-Packard
Crossley Sales Division
5579 Pearl Road
(216) 884-9209
TWX: 216-888-0715

Dayton, 45409
Hewlett-Packard
Crossley Sales Division
1250 W. Dorothy Lane
(513) 299-3594
TWX: 513-944-0090

PENNSYLVANIA

Camp Hill
Hewlett-Packard
Robinson Sales Division
(717) 737-6791

Philadelphia Area
Hewlett-Packard
Robinson Sales Division
144 Elizabeth Street
West Conshohocken 19428
(215) 248-1600 and 828-6200
TWX: 215-828-3847

Pittsburgh Area
Hewlett-Packard
Crossley Sales Division
2545 Moss Side Blvd.
Monroeville 15146
(412) 271-5227
TWX: 710-797-3650

TEXAS

Dallas, 75209
Hewlett-Packard
Southwest Sales Division
P.O. Box 7166, 3605 Inwood Rd.
(214) 357-1881 and 332-6667
TWX: 910-861-4081

Houston, 77027
Hewlett-Packard
Southwest Sales Division
P.O. Box 22813, 4242 Richmond Ave.
(713) 667-2407
TWX: 713-571-1353

UTAH

Salt Lake City, 84115
Hewlett-Packard
Lahana Sales Division
1482 Major St.
(801) 486-8166
TWX: 801-521-2604

VIRGINIA

Richmond, 23230
Hewlett-Packard
Southern Sales Division
2112 Spencer Road
(703) 282-5451
TWX: 703-282-9986

WASHINGTON

Seattle Area
Hewlett-Packard
Neely Sales Division
11656 N. E. 8th St.
Bellevue 98004
(206) GL4-3971
TWX: 910-443-2303

CANADA

Montreal, Quebec
Hewlett-Packard (Canada) Ltd.
8270 Mayrand Street
(514) 735-2273
TWX: 610-421-3484

Ottawa, Ontario
Hewlett-Packard (Canada) Ltd.
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MANUAL BACKDATING CHANGES

MODEL 410C

ELECTRONIC VOLTMETER

Manual Serial Prefixed: 433
hp Part No. 410C-903

To adapt this manual to instruments with other serial prefixes check for errata below, and make changes shown in tables.

NOTE

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the stock number given in the manual.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
433	Manual Applies	311	1, 2, 3, 4, 5, 6
344	1, 2, 3		
339	1, 2, 3, 4		
323	1, 2, 3, 4, 5		

NOTE
hp Part No. and hp Stock No. are synonymous.

CHANGE #1

Under Table of Replaceable Parts:
Delete: A3R20; Resistor, fixed, 1 K ohm; hp Part No. 0687-1021.
Add: A3R20; Resistor, fixed, 10 K ohms; hp Part No. 0686-1035.

Figure 5-10, Amplifier Schematic, change:
A3R20 from 1 K ohm to 10 K ohms.

NOTE
Later Models 410C (Serial Prefix 433 and above) use a 1 K ohm resistor for A3R20 to increase the meter zero adjustment (A3R21). It is recommended that earlier models be modified accordingly, in case of zero adjustment problem. Refer to hp Service Note 410C-1 for modification instructions.

CHANGE #2

Under Table of Replaceable Parts:
Delete: Q1; Transistor, PNP Germanium; hp Part No. 1850-0098.
Add: Q1; Transistor, PNP Germanium; hp Part No. 1850-0094.

NOTE
Later Models 410C (Serial Prefix 433 and above) use the hp Part No. 1850-0098 for increased reliability. It is recommended that earlier models be modified accordingly, in case of failure of the earlier type transistor. Refer to hp Service Note 410C-3 for modification instructions.

CHANGE #3

Under Table of Replaceable Parts:
Delete: CR7; Diode, Breakdown Junction, 9 v, 1.5 w; hp Part No. 1902-0327.
Add: A7CR7; Diode, Breakdown Junction, 9 v, 0.4 w; hp Part No. 1902-0037.

Figure 5-8, Power Supply Schematic, change:
CR7 to A7CR7. This designates that this diode is part of the Power Supply Assembly, A7.

NOTE
Later Models 410C (Serial Prefix 433 and above) use the 1.5 watt breakdown diode (hp Part No. 1902-0327) for increased reliability. It is recommended that earlier models be modified accordingly, in case of failure of the 0.4 watt diode. Refer to hp Service Note 410C-2 for modification instructions.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
433	Manual Applies	311	1, 2, 3, 4, 5, 6
344	1, 2, 3		
339	1, 2, 3, 4		
328	1, 2, 3, 4, 5		

CHANGE #4

Under Table of Replaceable Parts:
Delete: S3; Switch, pushbutton w/pilot light; hp Part No. 3101-0100.
Delete: DS1; Light, indicator, A1C neon; hp Part No. 1450-0106.
Delete: R5; Resistor, fixed, 68 K ohms; hp Part No. 0687-6831.
Add: S3; Switch, pushbutton; hp Part No. 3130-0054.
Add: DS1; Light, indicator, NE-2H neon; hp Part No. 1450-0048.
Add: Bushing, panel; hp Part No. 5020-0883.
Add: Actuator; AC switch; hp Part No. 5040-0918.
Add: Bracket; AC switch; hp Part No. 410C-12C.
Add: R5; Resistor, fixed, 33 K ohms; hp Part No. 0687-3331.

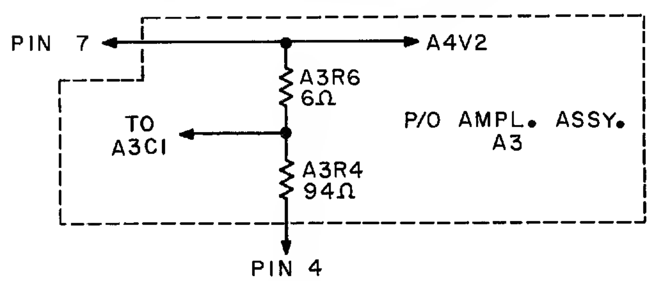
NOTE

Later Models 410C (Serial Prefix 344 and above) use the hp Part No. 3101-0100, pushbutton switch w/pilot light for increased reliability. It is recommended that this improved switch-pilot light assembly be used for replacement, in case of failure of the older type switch. Refer to hp Service Note P-3101-0100 for modification instructions.

CHANGE #5

Under Table of Replaceable Parts:
Delete: A3R3; Resistor, fixed, 100 ohms; hp Part No. 410C-26D.
Add: A3R4; Resistor, fixed, 94 ohms; hp Part No. 0727-0470.
Add: A3R6; Resistor, fixed, 6 ohms; hp Part No. 410C-26C.

Figure 5-10, Amplifier Schematic, change:



CHANGE #6

Under Table of Replaceable Parts:
Delete: A1R7; Resistor, fixed, 15 K ohms; hp Part No. 0687-1531.
Add: A1R7; Resistor, fixed, 22 K ohms; hp Part No. 0758-0020.
Delete: A2R2; Resistor, fixed, 10. 5 ohms; hp Part No. 0727-0955.
Add: A2R2; Resistor, fixed, 6 megohms; hp Part No. 0727-0460.
Delete: A2R10; Resistor, fixed, 6 megohms; hp Part No. 0730-0176.
Add: A2R10; Resistor, fixed, 10. 8 ohms; hp Part No. 0728-0005.

Figure 5-13, RANGE and FUNCTION Switching (Pictorial), change:
A1R7 from 15 K ohms to 22 K ohms.
A2R2 from 10. 5 ohms to 6 megohms.
A2R10 from 6 megohms to 10. 8 ohms.